THE

ENGINEERING MAGAZINE

VOL. XIII. JUNE, 1897. No. 3.

THE IMPORTANCE OF THE UNIVERSAL EXPOSITION OF 1900.

By J. C. Charpentier.

THE exposition of 1900 is now on the carpet. It is the question of the hour, and even in the remotest quarters of the globe it is the subject of many conversations and the occasion of many projects. In France the preparations for it are going forward with activity and are followed with interest; the temporary scaffoldings of the Pont Alexander III already stretch across the Seine, and a large part of the Palais de l'Industrie, one of whose wings sheltered but a few days ago the victims of the frightful fire in the Rue Jean Goujon, has been torn down. In foreign countries, especially in Germany, England, and in fact the whole of Europe, committees are being formed, plans are being sketched, and projects are taking shape; and even in the United States, where until lately more pressing problems, such as were involved in the national election, had absorbed the attention of the public, the current in favor of the exposition is swelling rapidly, and President McKinley invites his fellow-citizens to the great assizes with which a sister republic is to celebrate the close of the century.

And in Europe as well as on this side of the water the thought of every one reverts to the brilliant success of the exposition of 1889, which seems to have been the most memorable triumph imaginable, tempting one to renew the objection of a certain member of a former French cabinet: "What is the use of a new exposition, and how is it possible to break the record of 1889?"

Indeed, it was not simply a considerable competition of more than 60,000 exhibitors, an influx of more than 1,500,000 visitors from foreign countries and of 5,000,000 from the departments of France, but also an unprecedented movement of money, an enormous increase in commercial exchanges, in railway receipts (which made a leap that

Copyright, 1897, by John R. Dunlap.

year of more than 120,000,000 francs), in the work of the postal and telegraphic services, and in the movement of the minutest machinery of economic and industrial life.

And yet the organizers of the exposition of 1900 expect to achieve results still greater. And, however audacious their attempt may be considered, appearances thus far seem to justify them. Since the first exposition,—that of 1855,—the success of Paris expositions has been on an ascending scale. There were 10,865 exhibitors in 1855, 26,000 in 1867, 36,000 in 1878, and 61,000 in 1889. The admissions were only 5,000,000 in 1867; in 1889 they reached 23,000,000. It must not be forgotten, moreover, that in 1889 political reasons prevented the monarchical powers from participating officially, and that the national committees which in certain countries substituted private initiative for official participation seldom succeeded in presenting more than an embryonic exhibit. Now, in 1900 the participation will be universal. Furthermore, the exposition of 1889 had only 9 groups; that of 1900 will have 18 groups and 120 sections. The area allotted to exhibitors in 1889 was only 203 acres; in 1900 it will exceed 271 acres. The expenditure in 1889 was only 43,000,000 francs; 100,000,000 francs have been voted by the French parliament for the approaching international competition, and, finally, an attendance of 60,000,000 is expected. Again, the immense and peaceful struggle to which France has invited all the nations, coming at a time when commercial competition between the peoples of the earth has attained such activity, marks a cardinal date in economic life, and the spectacle offered to the world will be worthy of its admiration.

I.—THE SCENE.

To receive her guests Paris wishes to don holiday attire, and entertains grand schemes for her adornment. Chief among them are: (1) the Pont Alexandre III; (2) the two fine-art palaces; (3) the disposition of the banks of the Seine.

1. *The Pont Alexandre III.* On October 7, 1896, when his Majesty the Czar Nicolas II laid with a golden trowel the first stone of the monumental bridge which will bear his father's name, he not only gave to France a proof of his sympathy and confidence, but inaugurated for the great nations an era of peace and industry. It is not lightly and for months that these gigantic works are undertaken; it is for years; and this setting at work of thousands of laborers, this activity of entire France centred upon a single object, constitute one of the most eloquent manifestations of industry and peace. The construction of the Pont Alexandre alone is a task of long duration. Of the existing Paris bridges none are more than thirty meters in breadth, but this will measure nearly sixty; it will have but a single arch, of

immense proportions; the year 1897 will be devoted entirely to its foundations, the year 1898 to the metallic work, and the year 1899 to its decoration. Especial care will be given to this last; architectural motives and decorative figures, bold in conception and harmoniously disposed at the four corners, will make of it a veritable work of art.

2. *The two palaces.* These are to be built in the Champs-Elysées, and one can form no idea of the discussion which they have occasioned. To make room for them, in fact, it was necessary to tear down the Palais de l'Industrie, where all expositions and competitions and the art salons were held, and to this destruction much resolute opposition was offered. And yet the superior interests of the exposition demanded it; to use the language of one of the most ardent promoters of the exposition, France must not offer the old renovated and repaired; if she invites the world to Paris, the plan must be new, worthy of herself and of her guests. The cause of the palaces triumphed, and a grand competition was instituted for their design, resulting in the receipt of more than one hundred and ten plans signed by the most eminent artists. Those of MM. Girault and Esquié, both of which took the Grand Prix de Rome, were pronounced the best, and their publication warrants the assertion that the two palaces will constitute a *résumé* of French architectural art at the end of the nineteenth century. Twenty million francs are appropriated for their construction, and it will be insisted that the work be durable and definitive, it being the intention that the palaces shall survive the exposition that they may be used permanently for the salons, competitions, concerts, etc.

These two palaces, situated in the Champs-Elysées, will be, in short, the starting-point and the frame of the immense avenue which is to connect the Champs-Elysées with the Invalides and restore one of the finest views in Paris. At the outset the Champs-Elysées will present their fairy-like spectacle; then, crossing the river, the monumental bridge; farther on, the esplanade of the Invalides transformed into gardens laid out in French fashion, with balustrades, groups, basins, and plots of greensward, bringing into the heart of Paris a reminder of Versailles; finally, as a background, the sober lines of the Hôtel des Invalides, and, crowning all, the glittering gilded dome of Mansart.

3. *Disposition of the Banks of the Seine.* The idea of giving a special disposition to the banks of the Seine is neither less original or less happy. The stream of Mme. de Sévigné will be transformed by the wand of the architects into a vast Venetian canal lined with palaces and having broad banks, spacious, convenient, and restful, upon which the public may promenade. The picturesque façades of

the pavilions of exotic design will rise one above another, separated by terraces in the Italian fashion. In the daytime the activity of navigation, the multicolored flags, and the gaily-decked boats standing out in relief against the foliage of the trees will form an animated picture, full of color and sparkling gayety, and at night the fairy-like illuminations, for which all the resources of modern lighting will be drawn upon, and the glittering waters will furnish a marvellous setting for the Venetian entertainments and festivities.

II.—THE SECTIONS.

But the construction of a monumental bridge, the building of palaces, and the embellishing of the Seine furnish only the scene, the setting, in which the action will take place and the characters will move. I refer to the sections and their occupants, French and foreign exhibitors,—that is, the really instructive part of the exposition. The sections will be eighteen in number, distributed among as many palaces. Most important among them will be the palaces of Education, of Social Economy, of Decoration and Furnishing, of Pottery and Glassware, of Horticulture, of Foods, of Stuffs and Garments, of Machinery and Metallurgy, of Means of Transportation, of Electricity, of Navigation and Commerce, of Colonization, and of Literature and the Arts and Sciences. A special section will be established for Physical Contests, Sports, Bicycling, etc. But the two which promise to attract the most attention are, beyond question, those of the Means of Transportation and of Electricity. The former is entrusted to M. Jacques Hermant, who was the French architect at the Chicago World's Fair, and we may be sure that the new agencies of locomotion, notably the automobile carriages now so much used in Paris and London, as well as bicycles and the various sorts of street railway, will appeal to inventors and to the curiosity of the public. But the Palace of Electricity, under the management of M. Henard, will be one of the drawing-cards of the exposition. By day it will supply motive power to a series of machines, and at night, by a special connection, it will supply light for the illuminations of the Salle des Fêtes. It will be built entirely of glass, and will shine in the night like a gigantic beacon.

One of the most characteristic features of these sections and of the exposition itself will be the method to be adopted in their general organization. It has often been urged against expositions that their technical exhibits are nothing but vast commercial museums in which, to be sure, one may see machines, but machines that are not in operation, or, if in operation, are doing no productive work. Now, the finest commercial museum in the world attracts but few visitors; the vestibule is the most frequented part of it, and even that is sought only

on rainy days. It will not be thus with the exposition of 1900. Its essential and wholly new principle consists in the uniform placing, beside the manufactured product, of the machine used in its manufacture and the processes of its production; and this fertile principle, which does the greatest honor to the promoters of the French exposition and notably to its director-general, M. Picard, will transform the general physiognomy of the exposition, will give life to the features hitherto looked upon as uninteresting, and will give the public valuable object-lessons. Better still, a methodical plan is contemplated, whereby the visitors will be able to follow the raw material through its various transformations without deviating from the course of their promenade. It is in the operation of this immense work-shop that will be employed the electrical resources already mentioned.

III.—THE FOREIGN EXPOSITIONS.

All these extensive preparations, all these efforts on the part of France to make the exposition an unprecedented thing, were sure to make an impression on foreign nations and impel them to unanimous coöperation. Accordingly that is what has happened. Of all the foreign governments to which invitations have been addressed by France, but one, Egypt, has declined to participate officially. Two, it is true, the United States and Switzerland, have as yet made no reply, but all the other governments, sixty in number, have accepted officially, and almost all have already appointed their commissioners and presented their applications for space. Comparing these applications with those made in 1889, one perceives at a glance the considerable importance that the approaching exposition will assume. The following are the figures for the principal countries:

	1889. Square feet.	1900. Square feet.
Argentine Republic	17,600	27,500
Austria-Hungary	36,388	640,200
Belgium	150,242	259,864
Cape of Good Hope	0	44,000
Germany	25,264	396,000
Italy	57,171	121,000
Japan	28,589	107,000
Mexico	23,000	44,000
Russia	49,764	528,000
Spain	41,185	50,500

Some of these figures are eloquent. Germany, whose participation at Chicago occasioned so much comment, is preparing to do better yet. The emperor desired that the invitation be accepted, and he has been followed by the entire commercial interest of the nation, so that throughout the empire an extraordinary movement is in progress. The commissioners, MM. Richter and Lewald, were

among the first appointed ; at Berlin offices have been established, in which the work of organization is going forward, and active preparations are being made for this new economic struggle. Germany will be represented in all branches in which she can exhibit advantageously. notably in machinery, chemistry, optics, and electricity. Three other groups in which indisputably she will occupy a first place are those of protection of laborers, hygiene, and public instruction. Lastly, she will participate in the theatrical exposition by a model of the great Wagner theatre at Bayreuth.

England, which in 1889 had 230,000 square feet, has not yet made known the exact figure of her needs, but she has reserved her rights in expressing a desire that as much space may be allotted to her as shall be enjoyed by any other nation. No less notable are the demands of Austria and Russia, which in 1889 refused to participate officially, but which are determined on this occasion to give their full measure. Japan, too, with her application for 107,000 square feet, shows her intention of manifesting to the united world at Paris her quality as an industrial power of the first rank.

As we have said, the United States have not yet forwarded to the French government an official acceptance, or made known the extent of their participation. It is useless to try to conceal the fact that this silence has not failed to provoke comment. It has been remarked that, when the Columbian administration invited foreign nations to the Chicago exposition, France was the first of all to respond to the appeal, placing herself at the head of the list of coöperating countries. But the delay of the United States finds its very natural cause in the American presidential election and consequent change of administration, and it is perfectly well recognized in France that not the slightest significance is to be attached to it. Furthermore, President McKinley's warm appeal excludes all possibility of misunderstanding. Nevertheless the time has arrived when the United States should definitively join in this movement of the foreign nations. In these peaceful assizes in which the foremost industrial powers, England and Germany, are so actively preparing to measure themselves against France, it is important that the great commercial republic of North America should claim the place that belongs to her. In machinery and metallurgy her participation is indispensable. Her machinery ; her metallurgical plants, so surprising in their boldness ; her newspaper presses, which recently enabled certain great New York journals to accomplish results so marvellous,—these ought to figure at Paris as monuments of the industrial activity of this great nation. In the department of Means of Transportation the United States, which possess the greatest network of railways in the world, equal in extent to that

of all Europe, and superior in comfort and luxury to anything imaginable, should occupy a first place. As to their supremacy in electricity, is it not enough to mention the name of Edison? And just as Japan has manifested her intention of signifying to the assembled world her quality as a great industrial power, should not the United States also establish the important position of their maritime power by showing, in the department of Military Marine, the most recent models of their warships? But considerations so important cannot have escaped public attention, and there is no doubt that the United States are determined to participate in this great international tourney in a manner worthy of them.

The quasi-unanimity with which foreign nations have officially accepted, and the exceptional importance of the foreign exhibits, will constitute one of the characteristics of the exposition of 1900 and its superiority to its predecessor of 1889, in which, it will be remembered, official coöperation was somewhat rare. One of the consequences easily to be foreseen is that the sovereigns who have shown so much enthusiasm in entering into the plans of the French republic will be led by the same enthusiasm to personally respond to her invitations to visit the exposition, and Paris expects for 1900 an influx of royal visitors such as has not been seen since 1867, whose presence will be the most striking homage to the government of the republic.

But the chief importance of this competition will be found in its higher lessons. During the second half of this century scientific progress, especially in electricity, has been so rapid, inventions have been so numerous, and discoveries have been so brilliant, that we feel, as it were, the need of taking breath and of traversing with the eye the road which we have covered. In economic life it is necessary, not to halt, for economic progress allows no time for that, but to note from time to time the advance that we have made and register it by mile-posts. It is a wise and useful thing to measure the distance traversed, to compare it with that traversed by our rivals, and to derive, from this look backward, instruction and profit.

That is the service which universal expositions render. In this respect the exposition of 1900 promises to surpass all others. At this end of a century of progress all the nations invited by the French republic are coming, to take part in a grand international tournament. All of them understand how important it is for them to participate. Let us await them with confidence and serenity. It is a comforting, a reassuring spectacle,—these peaceful preparations of the civilized world. There is no surer sign of peace, for such displays and expenditures of activity and effort require luminous skies and sunny horizons.

THE PHYSICAL ASPECT IN RAILROAD ACCOUNTING.

By Thomas F. Woodlock.

RAILROAD accounting, in the sense of information published for the use of security-holders, constitutes a part of corporation management, which is, or should be, more important than many people esteem it. I believe that it might be made a most potent influence for good management and a thoroughly efficient protection for investors by the adoption of a rather different theory of construction of railroad reports. The suggestions which follow are the fruit of practical study of railroad reports, and are offered with some confidence, because a layman or investor may perhaps claim to know better just what he requires in the way of information about his property than even the trained and experienced accountant who prepares that series of abstracts from the company's books which commonly goes to make an annual report.

The study of the purely financial aspect of railroad reports, which practically begins with "net earnings," is good, as far as it goes. It is frequently very complicated, and occasionally makes considerable demands upon the skill and patience of the analyst. It is all built, however, upon the general assumption that the "net earnings" of the company are correct, and it busies itself chiefly with the disposition of "net earnings" and the manipulation of capital.

"Net earnings" are the *result* of "gross earnings" and "operating expenses," however, and only in these two items do we come really in contact with the operations of the machine itself, so to speak. Net earnings are, as it were, the power delivered on the first floor by belting from the engine in the basement. If we look only at the belt, we know nothing at all about the engine, and some day, when the belt stops, we are surprised, because it has run along without a break to the last minute. We ought also to study the engine, at least a little.

The point that I am endeavoring to make is that the majority of railroad reports—in fact, almost all of them—are lacking in that they do not bring readers close enough to the actual operations of the machine. They deal too much with results, and too little with causes. If they were so constructed as to show at once the real physical circumstances of the road's operations, a much better idea of the company's position would be given. In a word, the physical aspect has not been sufficiently considered in railroad accounting as a whole, and,

where it has been sufficiently considered to ensure publication of the main facts in the report, these facts, as a rule, have been so buried under detail as to convey but a confused idea to the lay reader.

If a man holds as an investment a stock or bond of a railroad, the chief thing that he wants to know is whether or not his interest or dividends will continue, and (if he holds a bond) whether or not the security for the payment of his principal is sufficient. As a matter of fact, the essential question at all times is whether or not *net earnings* will be always sufficient to meet interest or dividends, because security for principal eventually depends entirely upon net income. Therefore, what a security-holder really wants to know is whether the earning power of his property is increasing or diminishing, and whether it is what it ought to be. This involves comparison of a company's record in a given year with its record in previous years. It also necessarily involves a clear exposition of all matters directly affecting the earning power of the company.

The net earning power of a railroad depends upon two things: first, the character and volume of business offered to the company; second, its capacity for handling it economically. The first comprises all matters affecting rates, density of business, length of freight haul, or average distance travelled by each passenger, and other kindred matters. The second comprises all matters relating to operating expenses, such as the average train load of freight or passengers, the efficiency of motive power and rolling-stock, the condition of track and structures, etc. When a clear idea is obtained of these things, it is evident that a clear idea is obtained of the earning power of the company. What we want to know, therefore, is everything that bears upon these things in any appreciable degree.

I.—*Character and Volume of Business; Gross Earnings.*

(1) We want to know the sources of the company's gross earnings; what proportion is passenger earnings, what freight, and what miscellaneous. Practically all companies show this.

(2) It is very desirable that, in showing freight earnings, the amount in dollars and cents contributed by each kind of freight, and the tonnage of each kind of freight, should be stated separately. The average rate per ton per mile of each kind of freight should also be stated. Most railroads report the percentage of total tonnage borne by each kind of freight, but practically none give the statistics called for above. Presumably the statistics are available on the books of all companies. Their chief value would be in showing basic changes in the character of the company's business, thus explaining important changes in earnings and expenses.

(3) The "average haul" of each kind of freight should be sepa-

rately shown. This would be extremely valuable as affording annual comparisons which would throw much light on the conditions under which the company was operating. It could, of course, be calculated from the "revenue per ton" of each kind of freight by dividing it by the "rate per ton per mile," but it would be well to state it separately.

(4) The company should state in each of its reports the "passenger density" and "freight density" of the road for a series of years. "Density" is arrived at by dividing the "passengers carried one mile" and "tons carried one mile" by the mileage operated, and gives the best idea of the volume of business done by the road. Very few companies report it, although almost all report the factors necessary for its estimation. It would also be well to report separately the density of the principal kinds of freight, so as to show where a road is gaining or losing in business. At times this would be a most valuable showing, with a very direct bearing on net earnings and the cost of operation. Certain kinds of business are more expensive to handle then other kinds; hence the variations in proportion between the various kinds of freight, and the density of each, are full of significance as bearing upon net earnings.

(5) It is desirable that reports should show the *direction* of a company's business, especially freight. Most roads in this country run east and west or north and south, and some show the volume of business moving each way. This has a direct bearing on loaded- and empty-car-mileage. It is necessary that the character of the freight tonnage going each way should be shown, because a mere record of tonnage is not sufficient. If the business one way is all cattle, and the business the other way all grain or coal, it is clear that, while the tonnage may be apparently equal, the empty-car-mileage will be apparently unaccountably large, because cattle cannot be shipped in box or coal cars, nor can coal or grain be shipped in stock cars. Hence the necessity for distinguishing.

(6) It is desirable to state local freight and through freight separately. Local freight may be taken as that which originates on, or is destined to points on, the company's own line.

(7) When the line does a very large passenger business, passenger statistics should be shown in the same detail as that prescribed for freight,—the object being to show plainly the company's main sources of business, the character and volume of that business, the revenue derived therefrom, and the circumstances under which it is obtained.

(8) It is very desirable that, where the business of a road is unevenly distributed over the year, being very heavy in certain seasons and very light at other seasons, a clear statement of tonnage for each

month should be made. This might throw a good deal of light on the sufficiency or insufficiency of equipment when judged by the foreign car-mileage. A road which had a big rush of business for three or four months in the year might well afford to pay considerable car-mileage rather than burden itself with equipment which would be useless for the remainder of the year.

When statistics such as these are available, anyone can form a fairly clear idea of the kind of business a company is doing, and how it is likely to be affected by circumstances as they crop up. That is really the main thing an investor wants to know about his property, as far as gross earnings are concerned. It is an unfortunate fact that, while most railroad reports are replete with statistics bearing upon other matters, very few of them give anything more than bare outlines regarding the nature of the business from which they derive their gross earnings. Surely it should be possible to amend them in this respect without much trouble, and the facts called for above could probably be given without detriment.

II.— *The Handling of Business; Operating Expenses and Net Earnings.*

When an investor has a clear idea of the kind of business his company is doing and the circumstances under which it is being done, he wants to know whether or not the business is being done economically, and whether or not the condition of his property is being sufficiently maintained. He wishes to know whether the net earnings reported have really been earned after a proper charging up of expenses for all purposes, and he wishes to know also if the property has been kept up to a full standard of efficiency. Evidence on these points is largely circumstantial, but is, on the whole, very important and often conclusive.

He knows that net earnings are what remain after operating expenses have been satisfied, and he knows that operating expenses should provide for the actual cost of transporting freight and passengers and for the full and proper maintenance of the company's property. What he wants to determine is whether operating expenses have been too heavily charged for transportation and too lightly charged for maintenance. It is practically impossible to economize unsafely in the conducting of transportation, if the business is done, and it is also almost impossible to unwisely construe maintenance too liberally, as far as expenses are concerned. The first thing he looks to is whether or not sufficient expenditure has been made on maintenance.

(1) The amount of money spent on each mile of roadway for maintenance of all kinds should be clearly shown in comparison with previous years,—five at least, and ten if possible. It will be seen readily if there is a tendency to increase or decrease expenditures in this respect. The actual amount is of no great importance in itself, and

must necessarily vary very much on various roads, but a comparison with previous years is necessary as far as a given road is concerned.

(2) The amount of money spent for maintenance of equipment should be separately shown for locomotives, passengers, freight, and company cars, and the average expenditure on each locomotive, passenger, freight, and company car should be shown in comparison with similar figures in previous years. In this way the tendency of expenses will show itself very plainly. Few railroads report expenses in this way, and many of them do not afford materials for arriving at the required facts. It is commonly estimated that an expenditure for repairs and renewals of $1,000 per locomotive, $500 per passenger car, and $40 to $50 per freight car are about the level of average safety on standard roads. An investor must, however, be guided by the previous record of the road, especially taken in connection with capital expenditure for equipment. If this latter is heavy and expenses for maintenance are decreasing, the inference is that operating expenses are not being sufficiently charged. The converse, of course, is also true.

(3) Inasmuch as trains must be run, while maintenance may be postponed for a time, it is generally safe to reckon that little or no money is actually lost in direct expenses for conducting transportation. It is impossible to save largely under this head, and at the same time run the same number of trains. It takes about as many pounds of coal, pints of oil, and pounds of waste, and as many men and as much time, to run one thousand engine miles on one road as on another; at all events the variation will not be extremely large. Therefore it is extremely important to know exactly how much is being earned by each engine-mile, or, rather, by each train-mile, for it is in the waste or saving in train-mileage that money is gained or lost. Our investor therefore will call for a statement of the number of train-miles (freight and passenger), the number of tons of freight hauled in each freight train on an average, and the amount earned by each freight train per mile run; and similar information for each passenger train. Most companies report this information, but many do not. From it one can judge very closely of the relative efficiency of one's property. One road will show a constantly decreasing number of tons per train, while another will show an increase just as steady. The investor in the former property will have no difficulty in making up his mind that there is something wrong, and it will probably first show itself in increased expenses for "conducting transportation."

If he looks deeper into the matter, he will probably find the trouble in the maintenance-of-way department (arising from failure to renew rails, ties, bridges), or in the maintenance-of-equipment department,

in the shape of inefficient motive power, shortage of cars through failure to make renewals, etc. This shows the importance of a clear statement of average expenses for maintaining each mile of roadway, each locomotive, and each car, over a series of years. Every train-mile saved means, on an average, at least thirty to forty cents in money.

(4) Another important thing is the mileage of foreign cars on the company's road, together with the mileage of the company's cars on foreign roads. Large mileage of foreign cars, not offset by large mileage of cars on foreign roads, frequently shows shortage of equipment, and is one of those things that throw light on the condition of a property.

(5) The amount of tons carried, on an average, in each loaded car and the proportion of loaded cars to empty cars are also of importance in determining the efficiency of a property. Many roads state them, but many do not. It is needless to explain the bearing of these items.

By a comparison of items such as those above suggested with similar items in former years, an investor or critic can form a very fair opinion as to whether or not operating expenses are sufficiently charged (they are practically never overcharged, as regards items of *maintenance;* certainly never from a conservative point of view), and whether or not the property is being efficiently operated. From this he can determine whether or not the company is actually earning what it claims to be earning. That is really the most important thing to determine with regard to a railroad, and unfortunately it is just the thing that is not shown by most companies.

Once an investor has satisfied himself of the integrity of net earnings, he knows exactly the position of his security, as "fixed charges" are not susceptible of change or manipulation at will. We have already assumed on his part a knowledge of the ordinary features of a balance-sheet covering the company's finances.

The physical aspect of railroad accounting is therefore nowadays far more important than the more technical financial aspect, because it brings the investor closer to the actual causes, whose effects are shown in final results. No report is thus complete, unless it shows:

(1) The character and composition (actual in tons and percentage of the whole) of the company's business, and the circumstances affecting each part thereof, including length of haul, density, revenue, and direction of business.

(2) The circumstances surrounding the handling of this business, designed to show the efficiency of equipment and road-bed and sufficiency of expenditures for maintenance, as affecting the integrity of net earnings from operations.

The fact that railroad accountants have as yet failed to appreciate the full importance of the physical aspect of railroading is shown by the fact that the chief standard, or unit, or "coefficient," of efficiency—*viz.*, the train-mile—has not yet been fixed in scientific uniformity by all the railroads. It is very doubtful if any two leading railroads in this country report train-miles in precisely the same way. By train-miles are meant revenue train-miles, or train-miles directly earning revenue as opposed to "switching" mileage or "work" mileage.

While the train-mile may not be an absolute standard of comparison,—it is certain that no absolute standard can ever be discovered,—it is unquestionably the best. The running of trains is the characteristic act of a railroad, and the mile is the natural unit of distance. The running of a train one mile is, therefore, the natural measure of earnings and expenses. The problem simply is to arrive at a proper definition of a train, and a clear demarcation of the dividing line between an engine and car doing "switching mileage" and the same engine and the same car doing "revenue-train-mileage." Every railroad accountant seems to go as he pleases in this respect, with sublime indifference to the methods adopted on other lines. Hence the absence of values in comparisons now instituted on a train-mileage basis between two roads. By the adoption of uniform train-mileage, results could be obtained that would be worth something. It would be a good thing for the interstate commerce commission to work a little on this point, as they worked on classification of operating expenses, and as they are working on classification of freight.

I may perhaps be allowed to make the suggestion that in corporation matters it is quite useless to look to congress for wise legislation. The people who can in a moment institute the necessary reforms are those powerful bankers who control absolutely the railroad finances of this country. To be plain, Mr. J. Pierpont Morgan, for example, can do more in five minutes in this direction than congress is likely to do in five or fifty years.

If we ever get real corporation reform, it will come from these men. Some of them have accomplished something in this direction in the last few years. A Missouri Pacific annual report now is eloquent when placed alongside a report of the same company for five years ago. A closed construction account on Louisville & Nashville is a valuable lesson, though we learned it from depression. The silent revolution in Pacific Mail's affairs since 1893 is also significant. These are straws, but they show which way the current is flowing. Perhaps the current may be more than an eddy. It all depends on the great banking interests in our corporations.

ELECTRICITY IN THE MODERN MACHINE SHOP.

By Louis Bell.

I.—REASONS DETERMINING THE CHOICE OF ELECTRIC MOTIVE POWER.

THE uses of electrical energy in the mechanic arts are now so varied that it would require no small space merely to catalogue them. Many of these applications are utterly devoid of technical interest, consisting merely of coupling a motor to one machine instead of another. Overlooking, however, the whole field, the application of electricity to mechanical processes seems to divide itself, as Cæsar divided Gaul, into three parts. First, in point of time and aggregate commercial importance, stands the introduction of electric motive power into machine-operating establishments.

The inducement to this step is simply the lessened cost of power that comes from a method of distribution the most efficient yet devised, with the added advantage that comes from generating power in large units rather than small ones.

Second in order of present importance come electric labor-saving devices,—those applications of electric power which are primarily directed not so much toward the cheapening of the power used as toward its employment in the most direct way and with the minimum amount of labor. There are many operations in which the change from crude to refined motive power means an enormous reduction in the use of the human machine, and such change is in this country of particular economic importance.

Finally, we must consider the profoundly interesting class of cases in which the employment of electrical energy has not merely cheapened and facilitated some mechanical operation, but has radically changed the process itself, giving us not only new conveniences, but new methods. Here electricity comes to the rescue by revising or replacing old ways of doing things, and thus saving power, or labor, or both.

The present paper will deal with the problem of electric motive power alone, and more particularly with the why and how of its use in machine-driving.

If a large group of miscellaneous machines requires to be driven, electric power is economical for two quite distinct reasons. In the first place, if the plant is a small one, electric power can often be obtained for less than the cost of steam or other power generated on the premises. Second, electric motors can be so applied as to lessen the waste of power in its distribution to the various machines. As regards

the first count, the conditions of economy are easily found. The aggregate cost of providing the power for a machine shop, for example, can be taken directly from the current expenditures. This cost, however, must be honestly reckoned, including all the incidental items chargeable to motive power, with due regard for depreciation.

If, including interest on the net cost of changing the motive power and depreciation on the motor, the use of electric power is cheaper than the existing power, then the use of an electric motor is at once indicated, without entering upon other considerations. As a matter of fact, the cost of power obtained by small steam engines, or even by small gas and petroleum engines, is rather high,—far higher than is usually supposed. Particularly is this true when, as often happens, power is used somewhat intermittently. Where the maximum power employed in driving miscellaneous machinery is, say, not more than twenty-five h. p., it is pretty safe to conclude that the power used costs, on the average, about ten cents per horse-power hour. Indeed, until one reaches a full output of fifty h. p. or more, the cost for intermittent work, such as is found in machine-shop practice, is more likely to exceed five cents per h.-p. hour than to fall short of it. Even the gas and oil engines, which work very economically on a uniform full load, are costly for intermittent work, since they have high friction and use gas or vapor very inefficiently on light loads.

The exact cost varies so much with the conditions that figures are somewhat misleading, but it is safe to say that, when electric power can be obtained at five cents per h. p. hour or less, its use is tempting, and in most cases advantageous. A few simple computations based on the total power expense will put the matter in its proper light.

But this is far from being the last word on the subject. The object in view, when one is investigating electric power, is, first, last, and always, economy. Now, there are two distinct ways of cutting down the total of the yearly power bill. First, one may buy his power at a cheaper rate than heretofore; second, he may manage to lessen his consumption of power. With good fortune he may be able to effect both economies. Electric motive power may prove economical for either reason or both, but its power-saving ability has been, and will be, its strongest recommendation to the more intelligent portion of the public. The logic of the matter is as follows.

Of the mechanical power required in a machine shop only a very modest proportion is actually utilized in the driven machines. The major part is frittered away in worse than useless friction by main shafts and jack shafts and counter shafts, by pulleys fixed and idle, by belts straight, half turn, and quarter turn, and by hangers, generally out of line.

The amount of this wasted power of course varies very largely according to circumstances, ranging from only a few per cent. to more than ninety per cent., as the transmission mechanism between engine and tools is well or badly ordered. Careful tests made on steam-driven workshops in France three or four years ago give perhaps the best idea of the losses in question. Twenty miscellaneous workshops mostly equipped with machinery for metal and wood working showed an average loss of no less than 40.7 per cent. between indicated h. p. and the machines—equivalent to the loss of not less than one-third of the net mechanical horse power. These shops employed less than 50 h. p. each, but the figures for larger plants are not essentially better, since in these are found long and complicated systems of shafting if the motive power is a single engine, and, if not, then a reduplication of the conditions found in smaller shops.

The grossest inefficiency may generally be looked for in shops having very irregular demands for power and in those employing a very large number of very small machines. Under such circumstances the fixed losses due to the belting and shafting system are, on the average, so large that the power usefully employed may be quite insignificant. A flagrant example was recently investigated abroad. The case was one in which a workshop was fitted with forty-two light machines on small mechanical work. Each machine was belted to a small countershaft. These were driven by pulleys from two line-shafts, which were in turn belted to a jack-shaft driven by a belt from the prime mover. The net power on this first pulley was 22.28 h. p., while the forty-two machines received in the aggregate 1.8 h. p. The rest was used up in the transmission. It is obvious that in a case of this sort a large amount of valuable power could be saved by abolishing the whole system of transmission by shafting and belts, and driving each machine by an electric motor.

Allowing only fifty per cent. efficiency for the motor system, including wiring, the net saving of power is 18.68 h. p. Taking the cost even at three cents per h.-p. hour, which is very low, the saving in a year of three thousand working hours would be $1,681.20, almost enough to pay for the installation during the first year under ordinary circumstances. This is a rather extreme case, owing to the large number of very small drives, but others nearly as bad can be found without looking far.

It does not follow, however, that such an application of motors to individual machines will always pay. For genuine economy it is necessary to deal with conditions in which the possible saving in power is considerable, and the cost of installation not unduly raised by the character of the load. In the instance just given the machines were

all lightly loaded, so that no single motor of more than one-third to one-half h. p. would be necessary. Cases of intermittent use may readily arise, in which the average load would be very small, although any single machine might temporarily require several horse power.

The result of this would be to render necessary the installation of motors aggregating many times the average or even the maximum load, and the system may prove too costly. Take, for instance, a plant with twenty machines, requiring together 10 h. p. net to drive, while 10 h. p. is taken up in the transmission. If each machine should require at times 5 h. p., then twenty 5 h.-p. motors must be installed, costing say $5,000. Reckoning interest and depreciation at ten per cent., the annual fixed charge would rise to $500. The efficiency could not be very high under such load conditions. Allowing it to be .66, which is a very liberal estimate, the net saving in power would be but 5 h. p., worth, at three cents per h.-p. hour, $450 per year of 3,000 hours. There would thus be a net loss of $50, even if electric power could be obtained at the low figure mentioned, which would usually be impossible. If, on the other hand, twenty 1 h.-p. motors would do the work, there would be a material annual saving in electric power.

There are, thus, numerous cases in which the use of individual motors gives no direct economy in power. Nevertheless a saving may often be effected by using electric motors so disposed as to cut off a material part of the shafting losses. Sometimes a group of machines has to be driven at a considerable distance from the engine through a rather complicated system of shafts and belts. If a single motor can be installed for this group, there will frequently be saving enough to justify the application of electric power, even if there is no gain in the rest of the plant. In the original installation of a machine plant a little tact generally renders it possible to subdivide the machines into groups which can be driven by motors with very little loss in transmission. In existing installations this advantage is not so easy to secure. One of the chief difficulties is the usual lack of knowledge which prevails regarding the actual amount of power required by a machine, or group of machines, and the losses in transmission. Even the most skilful guessing is generally wide of the mark. No safe rule can be laid down for estimating the losses in shafting, as these depend upon the number and character of the supports.

For a rough estimate, however, one will not go far wrong in allowing 3-5 per cent. loss in efficiency for each belt drive, and 1-2 per cent. for each bearing surface, whether hanger or loose pulley. A transmission, then, with, say, four belt drives and thirty

bearings, would be likely to have a total efficiency perhaps as high as 55-60 per cent.,—possibly as low as 20-25 per cent. This is very loose approximation, but quite as close as the uncertain facts warrant. The larger figure can be surpassed, if the shafting is carefully designed and kept in good order, while the lower figure may be too high for shafting badly aligned and too lightly loaded.

The power required for the driven machines is similarly uncertain. It runs from minute fractions of a horse power to 20 h. p. or more in heavy metal-working tools.

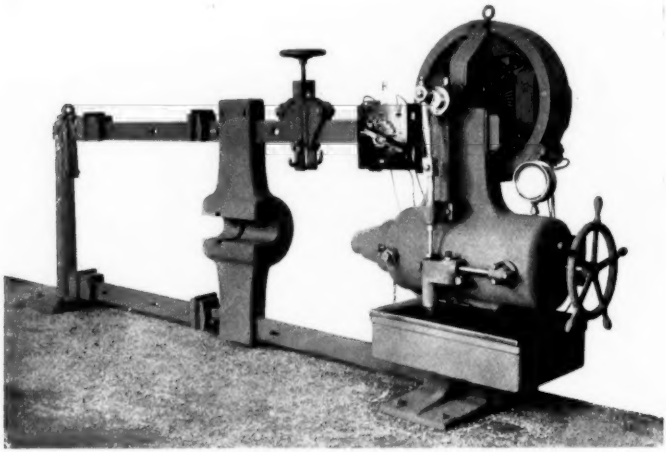
Recently some interesting attempts have been made to reduce the power required for metal working to terms of the hourly weight of shavings. The following are some of the results obtained on lathes:

	Material.	*H. P. Required.*
	Mild steel	.047 W
	Wrought iron	.0327 W
	Cast iron	.0314 W
For planers—	Mild steel	.012 W
	Wrought iron	.052 W
	Gun metal	.0127 W

W, in each case, is the number of pounds of metal removed per hour. These figures necessarily vary somewhat with the condition of the cutting edge, the character of the material, the shape of the cut, and so forth; but the general amount of the power needed is clearly shown. It takes a large lathe or planer to require more than 5 h. p., and during a great portion of the time of actual work the load is no more than a quarter or a half of this, including the friction of the machine.

It thus happens that the average load of each machine is far less than the full load, and, further, in actual machine-shop practice each machine is generally in operation only a moderate portion of the time. Therefore the average power required for the whole plant is usually considerably less than the sum of the average outputs of the individual machines while running.

This fact has an important bearing on the economic application of electric power. It is necessary not only to deliver efficiently the power needed for each machine, but to stop the loss of power when the machine stops. This condition indicates the use of individnal motors, which can be shut down to stop the machines to which they are attached. But we have just seen that such a proceeding may necessitate large motor-capacity, which increases the cost and lowers the efficiency. In any case, it is desirable to take the fullest advantage of intermittent use, and nothing facilitates this like the use of electric motors, for in every other general method of distributing



100 TON HYDROSTATIC PRESS, MADE BY THE NILES TOOL WORKS, DIRECTLY OPERATED BY ONE OF THE BULLOCK ELECTRIC MFG. COMPANY'S VARIABLE FIELD MOTORS.

power that part of the loss which is irrespective of the amount of power utilized is considerably larger.

There are, however, conflicting interests in determining just how electric power can be employed. Perhaps the best way of attacking the problem in any particular case is to take it up in sections, answering *seriatim* the following questions:

1. What is the actual average power now required at the main drive?

2. What is the actual yearly cost?

3. Can I buy the given amount of electric power more cheaply than I am producing power now?

These questions will define the existing conditions, apart from economies in transmitting the power.

The next step should deal with the transmission, and should be taken irrespective of the economy shown in the preliminary inquiries,—for one may over-balance the other.

4. How much total power is lost in shafts and belts?

This point is determined by measuring the power consumed when all the machines are off. In many cases indicating the engine very carefully is the best method of testing. Sometimes a temporary electric motor can be used for the same purpose. The investigation of these transmission losses should be as far in detail as the condi-

tions permit. By throwing off belts here and there the power required for each main shaft can be approximately estimated, or the motor can be moved from place to place with temporary leads.

Now begins the delicate part of the operation. It is easy to find the average power required when running under load, which constitutes the answer to question 5.

5. What is the average daily output?

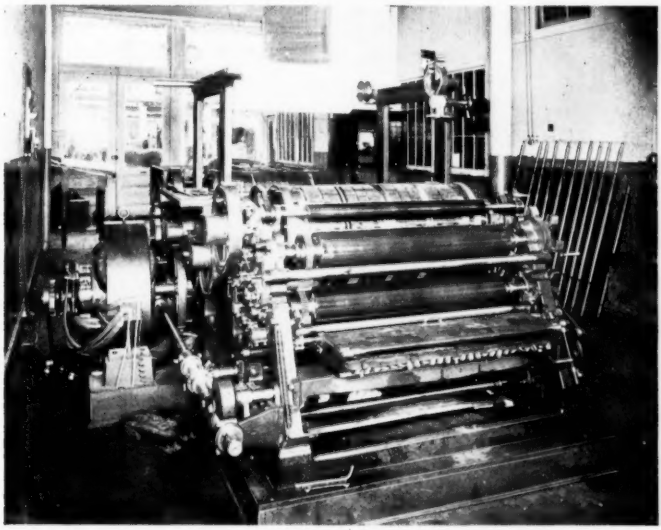
But, in order to know how electric motor power can most economically be applied, it is necessary also to know:

6. What is the average power and the maximum power demanded by each machine? and

7. What proportion of the time is each machine in operation?

The average and maximum power can be estimated for the larger machines much as the shafting losses were estimated. For small machines a temporary motor can often be arranged. These tests involve some trouble, but, if the answer to question 4 indicates the opportunity for considerable saving, they are well worth the while.

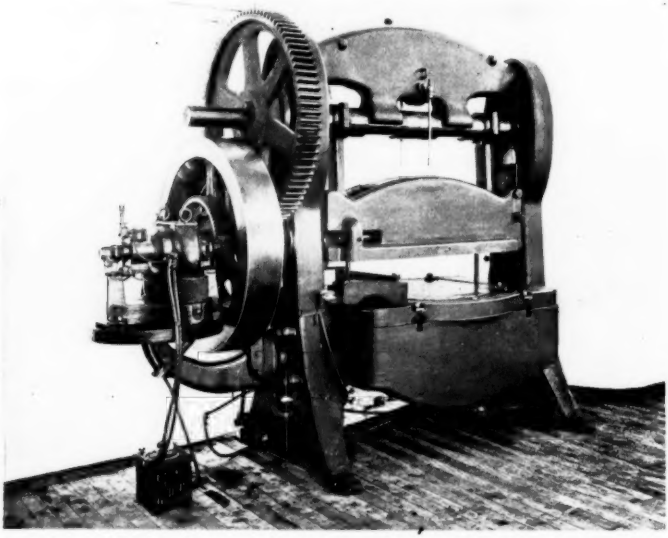
We have seen that there are two general methods of arranging motors: first, driving individual machines; second, driving groups of machines. The former is always popular on account of its neat appearance, but we have already found that it is not, under all cir-



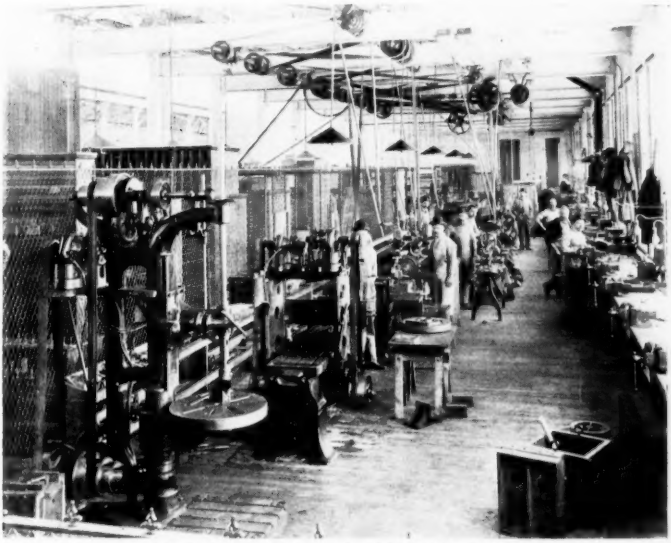
CAMPBELL-WEBB PERFECTING PRESS DRIVEN BY A THRESHER ELECTRIC MOTOR.

cumstances, economical. It appears in two forms,—the direct consolidation of the motor with the machine, of which several admirable examples are shown, and driving the machine by a belted motor located at the most convenient point. The first-mentioned device is very neat and efficient in new installations. It is not, however, always advisable, particularly in changing over an existing plant. It must be remembered that belting is the simplest and most efficient method of changing speed, and that most tools run at so moderate speeds that something of the kind is necessary. Very-low-speed motors are apt to be little, if any, more efficient than a moderate-speed motor with belting, and are more bulky and costly. Electric machine tools are admirable in cases where space is very important, or where the speed is high enough for direct connection or so low that considerable complication in gearing is unavoidable and cannot readily be helped out by belting.

Modern motors, particularly of the induction type, are very often placed on raised platforms or brackets, so that the question of floor-space seldom has to be raised. In working over an existing plant, it is more than likely that directly-connected or geared, and ordinary belted, motors will have to be used, each being employed where it will prove most effective.



LARGE FERRACUTE PUNCH PRESS DRIVEN BY CROCKER-WHEELER ELECTRIC MOTOR.

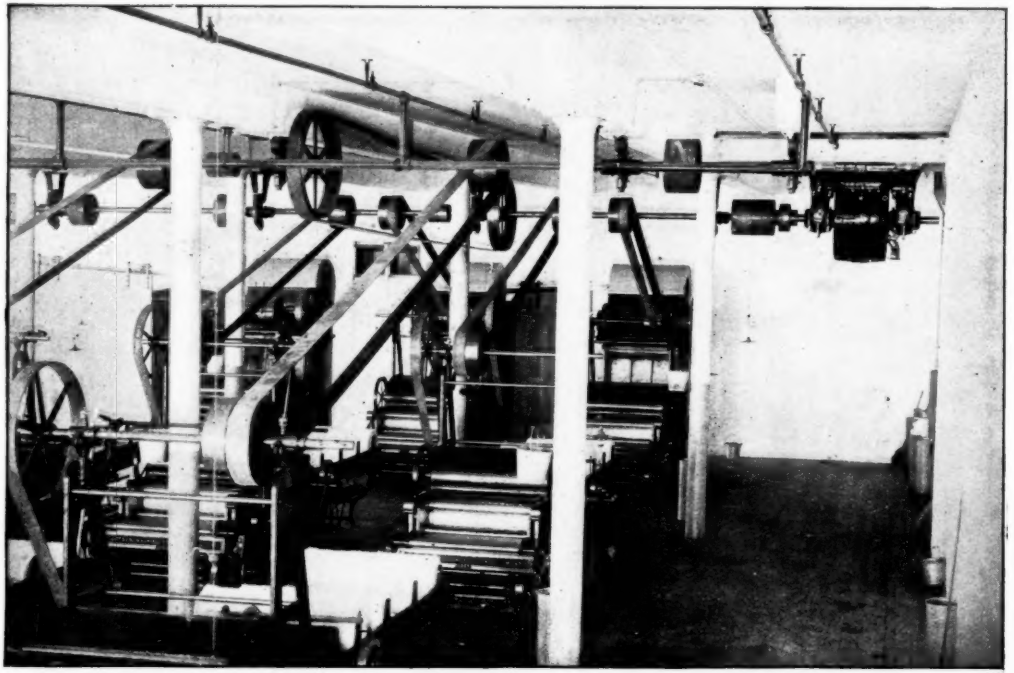


A GROUP DRIVE IN THE CROCKER-WHEELER SHOPS.

Group-driving is very often advisable, both in old and new plants, particularly if there are groups of machines using considerable power and using it steadily. A fine example taken from mill work is shown on page 356. Here a 65 h.-p. inverted induction motor is coupled directly to the main shaft, from which are directly belted the group of cotton-picking machines. A smaller application to machine-shop work is illustrated above. Used in this way, the motor drive is highly efficient, and it is certain that as much efficiency is gained by using a single large motor as is lost by the small remaining amount of shafting and belts.

Having approximate data on the power lost in shafting and that required by the machines, the approximate saving possible by electric power can be estimated. In arranging the motor plant the following general rules may prove useful, although the varying conditions found in practice cannot be reduced to precise rules and formulæ :

1. Abolish long shafts serving simply to transmit power.
2. Abolish quarter-turn drives.
3. A group of well and steadily-loaded machines is generally best driven from a single motor.
4. Machines requiring large and intermittent power are best driven by individual motors.



GROUP-DRIVING BY 65 H.-P. GENERAL ELECTRIC MOTOR IN THE PICKER ROOM OF THE COLUMBIA MILLS.

5. Machines having small average and large maximum power can advantageously be grouped.

6. Machines driven through long intervening shafts, or otherwise disadvantageously, should be supplied with individual motors.

Rules 3 and 5 are at first sight contradictory, but in the former the group-drive gains in efficiency by the substitution of a large motor for many small ones, while in the latter it gains by taking full advantage of intermittent use. In a new plant machines can be, to a considerable extent, arranged for economical driving, but in old plants one must do the best he can with existing conditions. This usually means frequent grouping and individual motors where they will do the most good.

In large and scattered plants it often turns out that it will pay to install a central electric plant and distribute power by motors. Experience shows that in such cases one can count upon an average net efficiency of about .65 to .70, or a little more, counting from the indicated h.p. of the engine to the motor pulleys. The exact figure depends on the ratio of average to maximum load. This is, as a rule, considerably better efficiency than can be obtained by any other scheme of distributing power, and enables the power to be produced far more cheaply than would be possible if separate engines were scattered about the shops. If such a plant is built for electric driving, there is a considerable additional saving in space and in cost of shafting and belts. Even in an old plant there are few cases in which the change to electric driving will not pay a large return on the capital so invested. Of the other and often greater economies due to saving in labor and the improvement in methods of working we will speak later.

CHARACTERISTIC AMERICAN METAL MINES.

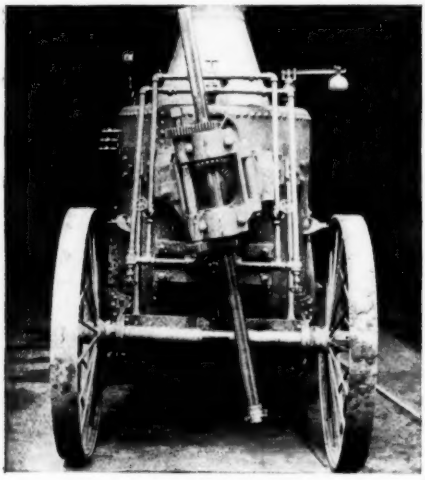
By J. Wyman Jones.

I. THE PLANT OF THE ST. JOSEPH LEAD COMPANY.

ANY one visiting the immense caverns, hewn from solid lime-rock, in the process of mining on the property of this company, located in southeastern Missouri, would require no other evidence of the magnitude of the work there accomplished.

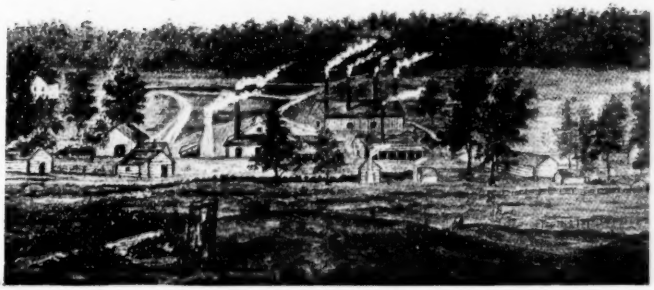
About fifty acres of underground rooms are witnesses of the millions of tons of rock that have been blasted, broken into sizes suitable for one man to handle, hoisted to the surface, crushed, and concentrated! These rooms are sustained by columns and arches, left in the progress of the work, and vary in height from twenty to seventy feet. They are inhabited, night and day, by men drilling, blasting, and loading rock, and by sleek mules which rarely, if ever, see the day-light.

The company was organized under the laws of New York on March 25, 1864. The capital stock (a million of dollars) was issued for the nine hundred acres of land first secured, and little was done until the meeting of the stockholders held June 13, 1865. At that time a board of trustees was elected, none of whom had any practical knowledge of lead-mining; but all were determined to push the work of development. The writer was elected president on September 25, 1865, and has held the office continuously ever since.



THE DIAMOND DRILL.

Lead mining in Missouri was exceedingly crude at this time, though carried on to some extent in several parts of the State. Here and there surface deposits were found and



BONNE TERRE IN 1865.

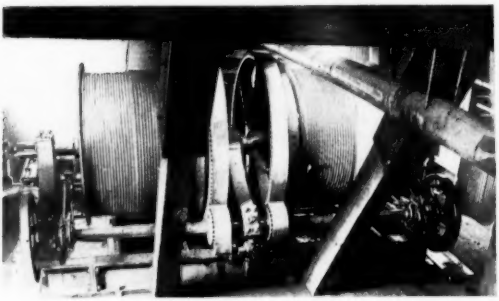
quickly worked out. Drilling was done by hand. Horizontal sheets from eight to eighteen inches thick were found in few places. No true veins had been discovered. No attempt had been made to work deep shafts. Continuous work was prevented by changes in the weather. In wet, very warm, or cold weather the open-cuts could not be worked. The disseminated surface-ores were mostly of fair quality. These were crushed, jigged, and washed by hand, and smelted in old-fashioned reverberatory furnaces, or "Scotch hearths."

After a fair trial of these unsatisfactory processes without profit, this company determined upon a more vigorous policy.

In May, 1867, the services of Mr. C. B. Parsons, as superintendent, were secured, and this able and excellent manager still remains in that position. Not long thereafter it was determined to search below

BONNE TERRE IN 1897.

the surface for deposits and to abandon surface work. A diamond drill (then first introduced to the public) was secured, a boring of 120 feet was made, and a shaft sunk. The diamond drill was the beginning of success. Once well below the surface, the work grew interesting.



THE DOUBLE HOISTER.

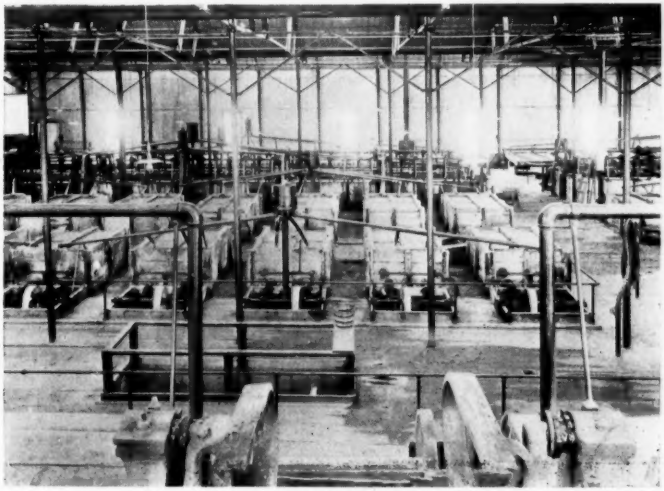
Drifting was commenced at the bottom of the shaft, and soon fair ore was discovered. From that day forward to the present date all mining has been done at depths ranging from 120 to 500 feet. With uninterrupted work, night and day, the output soon increased. In the thirty years which have elapsed since that day the huge caverns mentioned in the first part of this article have been blasted out, and have furnished the enormous tonnage of rock from which the lead has been extracted.

These excavations have grown naturally into their present proportions, in the course of development. They commenced with ordinary stopes, seven or eight feet in height. As drifting in these

THE MILL.

MILL, WITH TWELVE CRUSHERS AND MINED ROCK.

stopes continued, and as fair ore appeared in the top or bottom of any stope, the ore was taken out. A narrow track, about three feet wide, was laid in the bottom of each stope, and extended as fast and far as the drift was carried. All the rock was broken, lifted by hand into iron cars holding about a ton, and rolled, either by



INTERIOR OF MILL, SHOWING JIGS AND TABLES.

THE SMELTING PLANT.

hand or mule power, to the hoisting shaft. There it was lifted to the surface. The capacity of the double lift is a car for every minute in the twenty-four hours.

When working in the bottoms of these stopes, the tracks were lowered as needed, first on one side of the stope and then on the other. As the blasting of rock went on at the top of the stope, or

A TRAIN LOAD OF ORE.

at the bottom, or at the sides, the large rooms appeared in some cases from seventy to one hundred feet between roof and floor.

We have considered electricity as a power in the mines, but have not adopted it underground, either for lighting or for a motive power. The destruction of wires for lighting by heavy blasting, and of engines upon tracks, and the constant necessary changes of the tracks, have been obstacles too serious. The only use we have made of electricity has been for lighting the mill and works on the surface, and for blasting with the electric battery.

LYCEUM AND PUBLIC HALL.

We are at present hoisting from eight different shafts lying an average distance of one-fourth of a mile from each other, and varying in depth from 150 to 450 feet. The ores from all these shafts are delivered at the mill for dressing,—a part of them in iron cars drawn by mules on tracks laid in the mines, and a part by engines and cars on surface tracks.

NATATORIUM.

The ores of these mines are low-grade sulphids (Galena) associated with iron and copper pyrites, arsenic, nickel, and cobalt, and a trace of silver. The separation of these mineral substances from the ore disseminated through the country rock, and the concentration of the mineral, is an elaborate process, requiring rock-breakers, crushing rolls, sizing-apparatus, jigs, and percussion-tables. Although the ore

hoisted from the mines has seldom more than eight per cent. of lead, the result of the concentration is a product containing from sixty-five to seventy-five per cent. of lead.

Since the underground work was undertaken, the business of the company has been steadily extending. By the use of the diamond drill, the percussion drills, dynamite, double hoisters, pumps of

CATTLE BARNS AND CATTLE, BONNE TERRE FARMING COMPANY.

very large capacity, railway tracks, dump cars, improved air-compressors, and other modern facilities, the product has been increased from forty tons of pig lead a month to at least forty-five tons a day.

Notwithstanding this steady drain upon the mines, there is at present no falling off in supply. As the percentage of lead in the ore remains about the same, an immense tonnage of rock is crushed daily, averaging not less than one thousand tons!

The old styles of smelting have long been abandoned. A new smelting plant has been built on the Mississippi river, twenty-seven miles from the mines, midway between the mines and St. Louis, where all the mineral is smelted in blast furnaces.

One of the greatest obstacles in the way of a larger development was the need of better facilities for transportation. Located, as the mines are, fifteen miles from the Iron Mountain Railroad and twenty-seven miles from the Mississippi river, the company was dependent upon mule teams for moving both product and supplies, as well as ores, waste rock, and tailings. These became wholly inadequate. In 1880 the company completed a narrow-gage road to Summit, a station on the Iron Mountain Road, and in 1887 began the building of a standard-gage railway to the Mississipi river at Riverside, near the location of the smelters. This road was completed in 1890, and since then has been extended twenty-five miles southerly, and is now owned and operated by the Mississippi River & Bonne Terre Railway Company. Its cost was more than $1,100,000. It is fully equipped, passes through a splendid lead district, is fifty-two miles in length, and has proved a complete success.

This road has greatly reduced the cost of operating the mines, by the use of spurs and tracks to the different shafts, besides greatly lessening the cost of coke, coal, and other supplies, as well as the expense of marketing the product and handling tailings, etc.

From time to time large tracts of mineral and other lands have been added to the original plant, until they include about fifteen thousand acres. A new mill and dressing works (wholly of iron) have been constructed, and supplied with modern machinery.

A large number of dwellings have also been erected. Large expenditures have been made for new shafts and hoisting engines, underground pumps, etc., and the smelting plant has been built on the Mississippi river at Herculaneum. The capital of the company is now three millions of dollars. The company, previous to 1891, had developed an extensive farming business; and, as under the laws of Missouri, this use of its lands seemed questionable, the surface rights of all lands (reserving all mining rights) were transferred in that year to the Bonne Terre Farming and Cattle Company, a corporation organ-

ized to work the same. This company is now engaged in an extensive milk and dairy business.

The lead company has never suffered from a strike. It has paid good wages, and paid them promptly. Some of the present employees have continued with the company from the start—very many of them for years. An interest is manifested in all employees and their families. Good schools, churches, a free library, a hospital, etc., are maintained. A public hall, a swimming pool, and a bath-house have been built by the company.

A village of from five to six thousand inhabitants has grown up around the works, called Bonne Terre, where all the comforts and conveniences of modern life are found. This prosperous town is in marked contrast with the place as it was in 1865, and is now the centre of a thriving farming country.

There has been no conflict between the company and labor. About one thousand men have been steadily employed for thirty years.

It will be observed that the ore worked by this company is very *lean;* that immense quantities of rock have been handled; that its large product has resulted from the use of the diamond drill and other power-drills, high explosives, and most approved dressing and smelting works, accompanied by an energetic and careful management; and that a large part of the success attained has been secured by maintaining harmonious relations, through all these years, with labor.

ELECTRIC TRACTION UNDER STEAM-RAILWAY CONDITIONS.

II.

By Charles H. Davis.

IN the preceding paper on this subject, appearing in THE ENGINEERING MAGAZINE for May, 1897, the great resultant increase of revenue, under proper operative management, was shown to be frequently justification for the choice of an electric-traction system, even though its first cost and operating expenses might be far greater than that of a steam road. For the purposes of the general argument, this greater charge against the electric system was assumed. It is the purpose of this article to examine the assumption in detail, and develop a critical comparison of the two systems of installation and operation. For convenience in exhibiting their respective merits, the following divisions are arranged in tabular form, after the scheme commonly used for present steam-railway records. The prefixion of the word "electric" or "steam" indicates an item belonging exclusively to one or the other systems respectively, and having no counterpart in the other. In the discussion the same general conditions are assumed, whichever system is used.

FIRST COST:

RIGHT OF WAY AND REAL ESTATE.

CONSTRUCTION.

1. Engineering and surveying. 2. Clearing. 3. Grading, ditching, etc. 4. Tunnels. 5. Masonry, culverts, bridges, trestles. 6. Fencing, cattle-guards, road-crossings. 7. Ballasting. 8. Ties. 9. Rails. 10. Track-laying, lining, and surfacing.

(electric) 11. Rail bonding.

(electric) 12. Overhead-trolley line, or third rail.

13. Signals. 14. Telegraph. 15. Stations and all buildings (including building for central power stations of electric roads.) 16. Terminals.

EQUIPMENT.

(steam) 1. Locomotives and tenders.

(electric) 2. Motor cars or electric locomotives. 3. Passenger cars. 4. Freight cars.

(electric) 5. Electric feeder lines and ground return circuit.

(electric) 6. Central power stations (not including buildings which are considered under "Construction").

GENERAL.

1. Discount on bonds. 2. Interest on bonds to opening of road. 3. Taxes to opening of road. 4. Office expenses, salaries, etc., to opening of road. 5. Contingent and miscellaneous not itemized, to opening of road.

TOTAL EXPENSES:

MAINTENANCE AND RENEWAL OF WAY AND WORKS.

1. Repairs of earthwork to sub-grade. 2. Repairs of track. 3. Repairs of fences, cattleguards, crossings, etc.

(electric) 4. Repairs of ground return circuit.

(electric) 5. Repairs of over-head trolley line, or third rail.

(electric) 6. Repairs of electric feeder lines.

7. Renewals of rails. 8. Renewals of ties. 9. Renewals of ballast.

(electric) 10. Renewals of poles, or insulation of third rail.

(electric) 11. Renewals of trolley, or third rail.

(electric) 12. Renewals of feeders.

13. Repairs of masonry, bridges, trestles. 14. Repairs of buildings. 15. Repairs of signals.

TRAIN EXPENSES.

(steam) 1. Fuel for locomotives.

(electric) 2. Fuel for power stations.

3. Water supply. 4. Oil and waste.

(steam) 5. Repairs and maintenance of locomotives and tenders.

(electric) 6. Repairs and maintenance of motor cars or electric locomotives.

7. Repairs and maintenance of passenger cars. 8. Repairs and maintenance of freight cars. 9. Use of foreign passenger and freight cars.

(steam) 10. Locomotive services (wages).

(electric) 11. Motor car or electric locomotive services (wages).

12. Passenger train services (wages). 13. Freight train services (wages).

(electric) 14. Repairs and maintenance of power stations.

(electric) 15. Power station services (wages).

STATION, TERMINAL, TAXES, AND GENERAL EXPENSES.

1. Agents and station services (wages). 2. Station supplies. 3. Telegraph. 4. Taxes. 5. General officers and clerks. 6. Legal. 7. Insurance. 8. Stationery and printing. 9. Agencies and advertising. 10. Contingent and miscellaneous not included above.

ACCIDENTS, LOSS, AND DAMAGES.

1. To freight. 2. To passengers. 3. To property owned. 4. To property not owned.

INTEREST ACCOUNT.

FIXED CHARGES:

1. Interest on bonds. 2. Rentals.

GROSS RECEIPTS:

1. Passenger receipts. 2. Freight receipts. 3. Miscellaneous receipts.

The first cost of "right of way and real estate" for the same traffic, location, and similar general characteristics is the same; the only advantage electric traction seems to have is the saving which might come by greater flexibility in alignment, due to ability to more easily surmount heavier grades; this advantage is more imaginary than real, for electricity is limited to suburban traffic and short lines, where the additional cost to avoid heavy grades is of small moment; if they are not avoided, the loss of time would doubtless result in corresponding loss of revenue.

In "construction" account we find that items 11 and 12 apply

to electric traction only, while there are no items applying to steam locomotive traction only. These items might have been placed under the heading "equipment," as part of the things necessary in electric traction to replace steam locomotives, and which could be added to motor cars or electric locomotives as equipment for an electric road; this phase of the question will be discussed under the heading "equipment." The engineering of an electric line might cost more than that of a steam road, but not necessarily; if the chief engineer was a competent railroad man with a thorough knowledge of electrical engineering, the cost would be the same; otherwise it would be increased by that amount paid an assistant engineer with special electrical knowledge, unless the line was costly enough to warrant several assistant engineers, one of whom could be versed in electrical matters. The cost of surveying work, consisting of reconnaissance, exploration line ("shoo-fly"), preliminary, location, and their modifications or extensions, depending upon the importance of the line, its cost, character of city and country, etc., would be the same in either of the cases under discussion for any specific example. The cost of clearing, grading, ditching, tunnels, masonry, culverts, fencing, cattle-guards, and those parts of the system pertaining to these general items, is not affected by the choice of system. It might be thought, at first, that the cost of masonry would be affected, if lighter bridges and trestles could be used with electric traction, but the weight and size of masonry abutments, piers, footings, etc., would hardly be affected by any slight changes in the moving load, for they are much more dependent upon the weight of earth embankment that they support and the character of ground they are built upon, together with their height and length. If they perform all their other functions, according to the best engineering practice, they will usually be found far more substantial than theoretically they need to be in order to uphold the weight of the super-structure. The cost of road-crossings will be the same, except where the third-rail electric system is used; should the third rail be broken at a grade crossing (the present practice of the New York, New Haven & Hartford R. R. Co.), the cost of such crossing will not exceed the cost of those used on steam roads; but this makes an imperfect system, both as to continuity of power and lighting circuits. No highly successful means have yet been devised to overcome these difficulties, but, if they are ever properly solved, crossings will be more costly on third-rail electric roads than on steam railways. In the design of bridges and trestles the principal elements which determine their cost are the span, dead weight, live uniform load, concentrated live load at head of trains (locomotive and tender), the speed of trains, and the "ham-

mer-blow" of the reciprocating parts of a steam locomotive, especially when it coincides with the period of oscillation of a bridge (very objectionable on bridges which are too light); electric motors, either geared to the axles or gearless (concentric with the axle), have a rotative motion, and therefore do not produce the effects of the "hammer-blow" referred to above. Owing to the peculiar construction of the electric locomotive or motor car, a greater proportion of the total weight is on the driving wheels than is the case with steam locomotives; therefore, with the same tractive effect (weight on drivers), the use of electric locomotives or motor cars reduces the moving weight at head of train; the weight of tender is saved by the use of electricity. These three facts would theoretically enable bridges and trestles to be built lighter for roads using electric motors, providing the loads were not concentrated upon a smaller wheel base, were it not for the fact that the necessity of providing for constantly increasing weights practically offsets the theoretical saving which might be made. Were it possible to operate trains where every car was a motor car, the cost of bridges and trestles could be reduced. The cost of ballasting, ties, rails and track-laying, lining, and surfacing will be the same in either case (drilling rails for bonding is covered by item 11), although a small saving in maintenance of these items is possible for electric traction (discussed under "total expenses"), which indicates that the first cost could be reduced for the same cost of operating; yet, as this would be poor economy, the quality, weight, and general character should be the same in either case. By the use of electricity it might, at first, appear that the signal and telegraph system would be reduced in first cost; the only possible saving would be in the source of the current used, which forms so small a percentage of the whole that for our purposes any difference can be neglected.

Stations would cost the same under similar conditions, whether steam or electricity were used, while all other buildings, including the power houses of an electric system, would be equal in cost, whatever the system; although the electric road requires buildings for its centralized motive-power plant (that is, all but the transmission line and motors) which are not a burden on the steam road, yet these are no doubt balanced by round houses, coal stations, water stations, and the larger machine shops required for steam-locomotive repairs. Terminals will cost the same, whichever system is used. So far we have found that the first cost of construction is substantially the same, whether steam locomotives or electric motors are used, but, if the latter are adopted, some additional work is necessary,—namely, (11) rail bonding and (12) over-head trolley line, or third rail. It will at

once be seen that these items add considerably to the cost of construction of an electric road as compared with that of a road operated by steam locomotives.

As an example, which will show, in a general way, the increased cost of electric-traction construction, let us assume, without any pretension to exactness, that the line is single track, one mile long; average speed of trains (including stops), twenty miles per hour; headway, one minute; length, six cars (one being a motor car); total weight of train, two hundred tons when loaded to ultimate capacity; rails, ninety pounds per yard; average nominal horse-power, 300 per train, (will exert 450 h. p. or even more, if required, for short periods); total maximum average nominal horse-power per mile of track (one way) at above headway, 900; average loss in transmission, 20 per cent.; assumed average nominal horse-power at station, 1,125 (allowing for loss and including surplus power), located at one end of line. With these assumptions, we have the following approximate additional cost for construction, if electricity is used. The electric return circuit would consist of the two lines of rail properly bonded with copper wires; two 4/0 B. & S. G. wires to each rail joint, which would cost to-day (copper, 15 cents per pound), complete in place, including terminals and drilling rails, 70 cents each bond, or a total of $497. To this must be added cross bonding of lines of rails, which varies much in practice; for our case, we assume that this is unnecessary, if the bonds at joints are properly made and maintained with the care displayed on other parts of the system. Over-head trolley line would be of iron poles, centre construction (assuming that there would be a double track); trolley wire, 423,200 circular mills; poles set every 100 feet, each weighing 1,300 pounds ($30' \times 8'' \times 7'' \times 6''$) set in concrete, would cost for one mile, approximately, $3,237 (1/2 of poles with brackets and feeder supports, etc., set at $50.00 each; trolley 6,748 pounds at 15 cents, special line material, $500; labor, $400).

To recapitulate, one mile of track equipped electrically will cost:

(11) Rail bonding. In this case the cost of ground return circuit is not an extra cost against the electric road, for the rails are used, they having sufficient capacity to carry the current:—see "Equipment."	$ 497
(12) Over-head trolley line	3,237
Total extra per mile for electric road	$3,734

Under "equipment" we have eliminated freight cars (item 4) as already stated. Passenger cars would cost the same, electric lighting

and electric heating of one being balanced by gas and steam heat of the other. Should motor cars be used, carrying passengers, there would be a saving equal to the cost of one passenger-car per train in favor of the electric road. If an electric locomotive were used, there would be no such saving. If every car were a motor car, then the cost of a steam locomotive per train would be saved in the case of electric traction; this, however, would add to the cost of each car. The system is not possible to-day, though we hope it may be in the future. Steam locomotives and tenders are to steam roads what motor cars (or electric locomotives), electric feeder lines and ground return circuits, and central power stations (without buildings) are to electric railways. To show the relative costs, let us again consider the former example. Feeder line would be about two 4/0 B. & S. G. wires of bare copper, as the company owns the right of way, and crossings of public highways at grade are unlikely on roads of the character we are discussing; these would cost in place $1,117 ($1,012 for copper and $105 for stringing). It will be noticed that the trolley wire suggested is much larger than that used in general practice, and, as it has large carrying-capacity, part of its cost might have been included in the cost of feeders. It is unnecessary here to go further into this question. In our example the area of copper in the over-head system is 846,400 c. m. (circular mills), equivalent to 920 mills diameter, which gives a total cross-section of .657 sq. in. A 90-pound rail has an area of 9 square inches, cross-section; taking the relative conductivity of steel and copper as 1 to 6, we find that each rail is equivalent to 1.5 square inches of copper, and both rails to 3 square inches; therefore, until the over-head system had a cross-section of more than 3 inches, there would be no necessity of any copper ground return circuit, so long as the bonding section at joints was the same as that of the over-head work. In case the area of both rails divided by 6 is less than the area of over-head copper, the copper ground-return wire should be of that section equivalent to the excess in section of over-head copper. This ground return can be run on the pole line and connected down to the rails at intervals or along the track, as may seem best in any given case.

The central power station of 1,125 nominal h. p. could be erected complete (without buildings included under "construction") for $50 per horse power, which would provide a plant of the most modern kind, giving the greatest economy (in the largest sense); in general, it would consist of steel stack lined with fire-brick, water-tube boilers, pumps, piping, condensers, heaters, blowers, direct-connected corliss engines, direct-connected generators, slate switch-boards, best indicating and recording instruments, etc., with all the

best labor-saving and automatic devices which help to make a thoroughly successful plant. The total cost of power plant would be $56,250. We shall not discuss the use of an electric locomotive, but assume the use of motor cars drawing trailers. In the estimate of 200 tons as the weight of a 6-car train, one being a motor car, the car bodies assumed are 45 feet over sills, 51 feet over all, with two trucks having four wheels each, the wheels being 33″ in diameter; car body weighing 22,000 pounds, trucks, 13,000 pounds; total, 35,000 pounds; average maximum passengers, 150 at 150 pounds each, 22,500 pounds, making total weight of passenger car loaded 57,500 pounds. The motor car is assumed to have four motors, one on each axle, or geared to it, its total weight loaded being 112,500 pounds (56.25 tons loaded, 45 tons empty, all on drivers). The trucks of this motor car would be heavier than the trail cars, and with larger wheels. With two four-wheel pivotal trucks, the weight on each driving-wheel would be 14,082 pounds, loaded, and 11,250 pounds, empty. The trail cars can be assumed to cost, complete, for steam or electricity, about $3,500; the motor car complete, about $7,000. A steam locomotive and tender of the same power and tractive force would cost about $9,000 (engine, $7,700; tender, $1,300). It will be noticed that the heating of cars has had no consideration in this article; while this would add to the first cost of an electric system in increasing the required capacity of transmission line and power house, and would undoubtedly add to the cost of operating as compared with steam locomotive practice, yet available data are so unreliable that a discussion of them is postponed. To recapitulate, on the basis of our example, we have the following additional charges against electric traction:

Feeder line	$ 1,117
Ground return (in this case no additional cost)	
Central power station	56,250
	$57,367
Deduct difference between 3 motor cars and 3 locomotives and tenders	6,000
Total per mile	$51,367

To estimate a ten-mile road at ten times the above would be unfair, for, unless the train density remained the same on every mile and a power station were built for every mile, it could not be in direct proportion; in general, the feeder system increases in cost as the distance, while the power station increases in cost as the weights moved and their speed. There would undoubtedly be found conditions of

very light trains at very frequent intervals over short distances where the larger cost of locomotives and tenders would balance the items which usually make the use of electricity the more costly; these conditions must more nearly approach those which now exist in street-railway service.

"Electric feeder lines and ground return circuit" is placed under the heading "equipment" rather than under "construction" for the purposes of this article; in a system operated by electricity the opposite course would be pursued, and has been followed in considering "total expenses." "Central power stations" (all but buildings) would naturally be in the motive power department, and are so considered in this article.

"General" items of "first cost" would be unaffected by the character of the system; a few years ago, when the word "electricity" as applied to street railways was more attractive in banking and investing circles, higher prices for bonds might have been obtained by the use of that system, but elements of this kind are not within the scope of this article. Taxes are based on value, not on cost, and are therefore unaffected by any particular system.

TOTAL EXPENSES.

We have adopted the title "total expenses" in a literal sense, including all expenses of every kind, so that the difference between "total expenses" and "gross receipts," if on the right side, would give the amount which can be considered the actual net earnings of the line. "Operating expenses," which are generally treated as the usual and ordinary expenses of the system, include "maintenance and renewal of way and works," "train expenses," "station, terminal, taxes, and general expenses," and "accidents, loss, and damages," but not "fixed charges," although the latter form a great percentage of the actual total expenses, and have become a necessity in our industrial and financial development. The operating expenses include many items which do not vary with the amount of business or the character of the alignment,—such as salaries of leading officials; maintenance of way, works, and parts of the system, against that deterioration which is produced only by time, irrespective of the amount of business handled or work done; salaries of agents of all kinds, many of whom have to be employed whether business is large or small, etc. All of these might be called the "fixed operating expenses," and, as they often amount to nearly half of the total operating expenses, it will prove instructive and remunerative to keep railroad accounts so as to show this. To reduce the total expenses to the minimum consistent with true economy is as important as to reduce the first cost to the lowest amount, bearing the same axiom in mind. We will now consider

"total expenses" in detail, following the order of the tabulated statement.

First comes "maintenance and renewal of way and works," and the subdivisions under it. "Repairs of earthwork to subgrade" would be unaffected by the system used. Repairs of track, fences, cattle-guards, crossings, etc., renewals of ties, and ballast are substantially independent of the volume of traffic; ties wear independently of the tonnage, for the so called "cutting" of ties is due primarily to the rotting away under the rail foot, accelerated somewhat, but almost inappreciably, by the decayed material cut away by passing loads. The total cost of track labor is affected only a very small percentage of the whole by any change in the amount of traffic, provided the standard of maintenance is not increased; rail-renewals, track-watchman, and part of the labor of lining, surfacing, etc., directly applicable to the track itself, are the only items which vary directly with the number of trains. One-half to three-fourths the wear of steel rails is caused by the locomotive, and is due more to the great concentration of load on the driving-wheels, which often nearly approaches the ultimate crushing resistance of the rail, than to the "hammer-blow" of the reciprocating parts. Maintenance of crossings would be unaffected by the system used, except possibly in the case of the third rail, already considered under the heading "construction." For the reasons enumerated above, items 2, 3, 7, 8, and 9 would be unaffected in cost of maintenance, whichever system were used. Maintenance of bridges and trestles should be slightly less with the use of electric motors, because of less vibratory effects; maintenance of masonry, buildings, and signals would not vary in cost with change of system. We find under "maintenance and renewal of way and works" that there are no items exclusively applicable to steam-locomotive practice; but there are six which apply to electric traction only. This naturally arises from the fact that these items occur under "first cost," and must be maintained. They are: maintenance of (4) ground return circuit, (5) over-head trolley line, or third rail, (6) electric feeder lines, and renewals to (10) poles or insulation of third rail, (11) trolley or third rail and ground return, and (12) feeders. The maintenance and renewals of these constitute an increase in the total expenses of an electric road over those of a road operated by steam.

The next division is that of "train expenses." We omit discussion of freight items, for reasons already given. The relative consumption of coal by steam locomotives and motor cars (electric locomotives are not considered), while of importance, is not so large a percentage of the operating expenses as is usually imagined; as a

rule, the attempt to save in fuel account has had more attention on electric roads than was warranted, and has been made at the sacrifice of other and more important items (for greater details see article by the author, entitled "Comparative Economy in Electric Railway Operation," published in THE ENGINEERING MAGAZINE, March, 1897). Omitting results obtained from compound locomotives, the records of which are not yet as extensive as those for single expansion, but which should show an average saving of approximately 20 per cent., it has been found that in steam-locomotive practice, of the character we are discussing, the coal-consumption per passenger-car-mile (exclusive of engine) averages about 6.5 pounds for cars weighing 20-25 tons on way-trains or 30-35 tons on through trains, and that about an average of one pound is added per car-mile for each 6 tons' added weight of car. The average coal-consumption of a passenger engine (say 40-45 tons) is about 20 pounds per locomotive mile; if we assume 6 cars to a train, as per our example, we have 3.3 pounds per car-mile for the engine and 9.8 pounds per car-mile for the whole train, including engine; this conforms to present average practice of steam railways. In the article referred to above the average coal-consumption per car-mile, under the best conditions of electric street-railway practice, is found to be about 8 pounds; the average weight of these cars, loaded, cannot exceed 8-10 tons, so that our six-car train would consume 48 pounds per train mile for a maximum weight of 60 tons and average speed certainly not exceeding 10 miles per hour; while with our steam train the consumption would be 58.8 pounds per train-mile for a maximum weight of 200 tons and average speed of 20 miles per hour. The great difference in coal-consumption per car-mile in present steam-railway and electric-street-railway practice, so much in favor of the steam road, is no doubt partly due to lower efficiency of the complete motive-power plant of the electric road (station, line, and motors), but most largely to crude controlling devices on cars, poor track, sharp and poorly laid curves, steep, uncompensated grades, and the poor class of labor employed. Average practice gives about 5.5 pounds of coal per i. h. p. per hour in steam locomotives, but the character of the service makes it liable, in any given run, to enormous variations. At times this figure is very much exceeded, and also often falls, under favorable conditions, to 4.5 pounds. The conditions which produce so large fluctuations in steam-locomotive service do not exist in the central power station of an electric road. In the latter case we cannot safely figure on less than about two and one-half pounds of coal per i. h. p. per hour. This may be reduced in exceptional cases, but will more often be exceeded. Apparently this is a decided saving in favor of the electric

road, but it is only apparent. Let us assume the following efficiencies, which are fair averages: engine, 90 per cent.; dynamos, 90 per cent.; line, 80 per cent.; and railway motors, 75 per cent (in considering these figures it must be remembered that most of the time the larger part of the system is running considerably below its rated maximum point of economy; some engineers might place motors at 80 per cent.), making the combined efficiency of the entire system about 48.6 per cent. It therefore appears that, for a given average horse-power required at the driving-wheel to move trains, double that amount, or, for safety, even more, must be placed in the central power station, making the coal consumption 5.1 pounds per i. h. p. per hour at the motor car, which is but little better than the average of single-expansion steam-locomotive practice, while it is probably no better than compound steam locomotives will give. The cost of handling coal would be substantially the same with either system, as there would be only one coaling station in either case. The cost of water would undoubtedly be greater in steam-locomotive practice, where it must be supplied at various points along a long line; but on short suburban lines, to which our discussion is limited, the steam locomotive could make a round trip without requiring water, or would have to be supplied only at each end of the line; and, as the central power station would use much more water on account of larger horse-power and the use of condensing, it is hardly likely that there would be any great difference between the systems. The use of oil and waste on the motor cars should be much less than that which is necessary for the proper care of steam locomotives; electric motors can have their wearing parts run in oil boxes, which are a protection against dust and dirt and automatically lubricate the surfaces subjected to friction, but this cannot be done in the case of steam locomotives. This saving in an electric system is, however, counterbalanced by the use of oil and waste in the central power station, so that it is unlikely that there would be much, if any, difference. Repairs of passenger locomotives and tenders on steam roads average from 4 to 6 cents per mile, with about 1.5 cents to be added for repairs to tools, shops, machinery, etc., properly chargeable to "motive power repairs." Statistics of electric roads are very imperfect and unreliable on matters of this kind, not only because such roads have usually been operated by those familiar with horse traction and having little mechanical knowledge of or inclination towards the precise methods of steam-railway management and operation, but because of the constant change of apparatus long before the old had given the life which could reasonably be expected of it as a piece of mechanism.

Even if we had such data as we might wish from existing electric

roads, they would be only indications of what might be expected on a system similar to the one under discussion. The total operating expenses per car-mile of electric street railways vary to-day from about 9 cents to 20 cents, and for our purposes we can assume that an electric road, built on its own right of way and operated under circumstances somewhat similar to those of a steam railway, but with the present equipments of our electric roads, can be operated at a total cost of about 13 cents a car-mile. In comparing repairs and maintenances of motor cars with those of steam locomotives, we must consider not only the motor cars themselves, but the power house (and the transmission line, had we not placed this under another heading). Of the above total about 3 cents is chargeable to total repairs of motor cars and central power house (.005 cents to central power house and .025 cents to motor cars), to which might be added three-quarters of a cent for transmission line. When we remember the small horse power involved, and the light weights and low speeds, it is hardly likely, with the large increase in these necessary under steam-railway conditions, that the cost of repairs and maintenance of the motive power of an electric road will be any less than that of a steam road. It is to be regretted that more reliable and extensive data are not obtainable. Repairs and maintenance of passenger cars would be the same in either system. The item "use of foreign passenger cars" is the rental paid for the use of cars of other roads while retained, and of course would be unaffected by the use of any particular system. While the operation of a motor car involves far less labor than that of a steam locomotive and its tender, yet the danger that the operator might be incapacitated makes it necessary to have two men at the head of the train, although one man would easily be able to do all the required work. As it takes two men to run the ordinary passenger locomotive, there would be no advantage of one system over the other. It would be a mistake to save wages by utilizing a lower degree of intelligence or skill for motormen and their assistants than is now used for engineers and firemen on steam railways; the tendency to do this has cost electric-street-railway owners many thousands of dollars,—more, in fact, than is usually realized. Passenger-train service would not be affected by the use of one system or the other. Central power station service is an additional charge against the electric road.

We now come to "station, terminal, taxes, and general expenses," divided into ten subdivisions, none of which are affected by the character of road-bed, rolling stock, or mechanical apparatus of any kind, but which are dependent upon the character of the business handled and its volume; therefore these items are unaffected by the

use of any particular system. The same statement applies to the division, "accident, loss, and damages," and to "interest account."

"Fixed charges" include interest on bonds and rentals; the actual rate of interest on bonds is not affected by the system used, except in ways beyond the scope of this article. We have shown that the first cost of an electric system is considerably greater than that of a steam-locomotive road (except in one special case); therefore the fixed charges will be much higher (assuming of course that the cost in each case is covered by bonds). This is no inconsiderable item, as the average fixed charges of our present steam roads are not less than twenty per cent. of the gross receipts, and, if this is largely increased by the use of electricity, it is more of a burden than can be overcome by inconsiderable savings in items of operating expenses (if such savings are even possible), such as slightly lower coal consumption, motor car repairs and maintenance, bridge repairs and maintenance, track repairs and maintenance, etc., which may be claimed in favor of electricity by some ardent advocates, irrespective of the intrinsic merits of any given problem.

In considering the total expenses of both systems, we have shown that the following would be additional charges against the electric road over those of a steam railway: renewals and repairs of transmission line; interest on bonds to pay additional cost of electric road (omitting probable excess of motor car and power house repairs and maintenance above those of steam locomotives). We have also shown that they would not be inconsiderable, especially the interest charge. These are items of sufficient importance to necessitate a very careful study of each individual problem before deciding upon a change, or even an original installation; but the great increase in gross receipts and in net revenue may, and very often will, decide the question beyond any possible doubt in favor of electricity, always remembering that the adoption of electric traction means a corresponding adaptation of operative methods, and not the mere application of a special form of motive power.

DEEP WATERWAYS FROM THE GREAT LAKES TO THE SEA.

By Allan Ross Davis.

THE annual passage of some twenty-five million tons of freight along the St. Clair river—the sole water avenue between the great northwest and the Atlantic seaboard—as well as the prospective increase of the carrying trade on the Great Lakes from year to year, demanding enlarged and cheaper transportation facilities, renders any attempt to provide an alternative route of the utmost importance to the commercial interests of the United States and Canada.

The movements of the deep waterways commissioners appointed by the respective governments are, consequently, being closely watched, and the result of their investigations is anxiously awaited.

In the meantime, in addition to the several schemes already advocated from an American standpoint for the solution of the problem, three Canadian schemes have been submitted, having for their object the construction of a shorter alternative route across the province of Ontario to connect Lake Huron with Lake Ontario and the St. Lawrence, and thus avoid the southwest peninsula and the Welland canal. These are:

(1) The Montreal, Ottawa, and Georgian Bay canal.

This route follows the line of the Lachine canal and the Ottawa river with its system of canals to the city of Ottawa, a distance of 110 miles, thence continuing 200 miles further up the Ottawa to its confluence with the Matawan river from the west, up which the ascent will be made to Lake Nipissing, 40 miles in length and an average of 15 miles in breadth, and thence descending from this summit level by the French river to the east shore of Georgian bay. The total distance from Montreal to Georgian bay through this depression in the earth's formation is 430 miles, of which the government engineers have reported 400 miles to be navigable for vessels of a considerable size. The rest of the distance of 30 miles requiring canals has been already partially completed,—that portion between Ottawa and Montreal,—leaving but 15 miles of canal to be constructed to complete the link. The cost of this undertaking, it has been estimated, would not exceed fifteen million dollars, affording nine feet of water.

(2) The Hurontario ship canal.

This is a Toronto project to construct a canal from Lake Ontario

at Toronto to Lake Simcoe 35 miles north, thence traversing the latter some 30 miles to Orillia, to descend to Georgian bay by a system of locks and dams down the 40 miles of the circuitous Severn river; or by cutting a channel directly across country for 13 miles to the same objective point. The western terminus of this route is about 100 miles south of the mouth of the French river, the terminus of the former route. The supplying of water for the increasing demands of the city, and of electric light and motive power for manufacturing and locomotion purposes, are important features of this Toronto canal scheme. Surveys have been made and approximate estimates submitted, which, it is claimed, justify the immediate carrying out of this extensive project. Toronto, however, is not anxious to turn over the source of its future water, light, and power supplies to a private corporation. Hence the Hurontario ship canal scheme has not made any material progress since its inauguration.

(3) The Trent canal.

This project had its inception in the early part of the century, when the English government was assisting her struggling Canadian colony in the settlement of the remote regions beyond tide-water. The Trent navigation system was an important link in the project to open up a military and commercial highway from Montreal to the Great Lakes at that period. The rapids of the St. Lawrence were too formidable and the Niagara barrier too stupendous to allow nature's route from the upper lakes to tide-water to receive serious consid-

SCENERY ON THE ROUTE OF THE TRENT CANAL.

ON THE LINE OF THE TRENT CANAL.

eration. A back-door route was, in consequence, adopted. The Lachine, the Ottawa river canals, and the Rideau canal, 126 miles from Ottawa to Kingston, were then constructed. Reaching Lake Ontario at Kingston, the government sent its engineers ahead up the Bay of Quinte 80 miles, with instructions to examine one of its northerly arms, the Trent river, and the chain of lakes extending to the northwest, down which Champlain returned from Lake Huron some two hundred years before, on his memorable expedition into the unknown west. It is worthy of note that Champlain ascended from Montreal *via* the Ottawa river and Lake Nipissing to Lake Huron, along which canal route (1) now follows, and descended *via* the chain of lakes and rivers now under consideration and forming the route of the Trent canal. The government engineer, N. H. Baird, M. I. C. E., subsequently submitted his report, with accompanying plans and estimates of the necessary work to be done between the Bay of Quinte and Georgian bay.

This original plan of the route, dated 1836, and entitled "Diagram of the Water communication through the Home and New Castle Districts from Lake Huron to the Bay of Quinte," though yellow, torn, and soiled, is still frequently referred to by the engineers of the Trent canal. Baird's estimate gave the total distance as 171 miles, with rise and fall of 707 feet, and a cost of £495,515. The report being favorable, an appropriation was at once made by the English government, and work began at the Bay of Quinte end.

The rebellion of 1837 interfered with the continuance of the work. After the completion of some short sections of canal, operations were suspended, and the appropriation devoted to quelling the rebellion which W. L. McKenzie had succeeded in stirring up. The engineer's report shows a continuous profile of the Rideau canal, the Bay of Quinte, and the Trent canal. This, without doubt, was the government canal route favored in those earlier days to connect the east with the west. No sooner, however, was the Rideau canal completed than the government saw that it was inadequate for the increase of traffic.

The St. Lawrence river system of canals was now deemed necessary, and construction thereon was energetically begun. Then, too, the influence of the prosperous Welland peninsula became felt in parliament, and the advocacy of the Welland canal, to connect Lake Ontario with Lake Erie rather than with Lake Huron, was zealously carried on. The sparsely-settled district contiguous to the interior Trent canal could not command the political influence of its populous frontier rival. The Trent canal was consequently side-tracked, and the construction of the Welland canal begun.

Nearly half a century elapsed before the advocates of the Trent canal, now grown numerous and commanding several important constituencies in central Ontario, could get the ear of the government. Meantime the other canals had been completed, the confederation of all the provinces into a compact dominion had taken place, and a new

ON THE LINE OF THE TRENT CANAL.

government had been elected, destined to hold the reins of power for eighteen years.

The people interested in the Trent canal now made emphatic demands for the carrying out of the original project. Canada's late premier, Sir Charles Tupper, then minister of railways and canals, personally inspected the Trent canal route, and reported favorably. Operations were begun by the construction of several excellent locks and dams in the interior, connecting a series of lakes of considerable proportions, but no extended sections of the canal were placed under contract.

The government did not feel disposed to take any more steps in this direction than became absolutely necessary, owing to the fact that the country, as a whole, looked upon the project as a useless expenditure of money. It was a freely-discussed question in parliament, and had many strong opponents. A dozen constituencies bordering thereon,

TRENTON, ONT., AT THE MOUTH OF THE TRENT CANAL.

whose representatives for the most part were government supporters and ardent promoters of the canal, could not, however, be thrown overboard.

The general election of 1891 was approaching, and some tangible evidence of the government's intentions was demanded. The premier, Sir John A. MacDonald, appointed a commission consisting of two prominent engineers, Frank Turner and John Kennedy, and Judge J. A. Weller, to "consider the question of further extending the line of water-communication between Lake Huron and Lake Ontario, and to determine whether any local works are necessary, and whether it is advisable that an extension of the main works should be undertaken, and, if so, to what extent."

This report, dated Montreal, December 17, 1890, after touching upon a variety of phases of the subject, concludes as follows: "In the opinion of the commissioners, a waterway would thereby be made

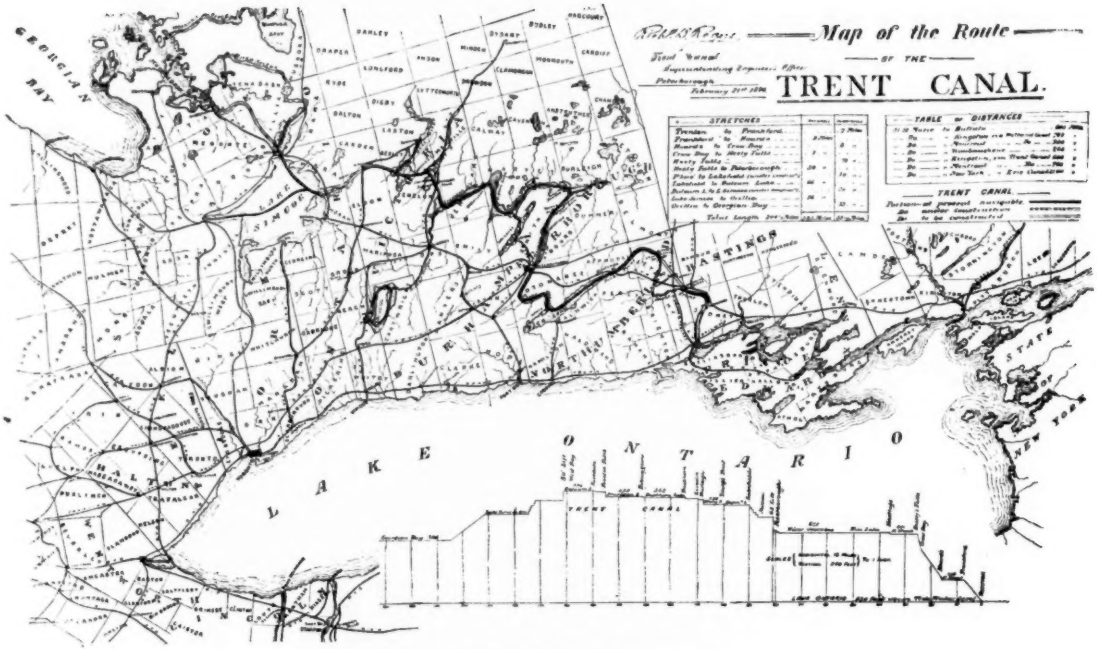
which would not only greatly increase the value of the works already constructed, but would assist and develop the industries along its route, and open up the resources of the country through which it would pass to such an extent as to amply compensate for the expenditure necessary to be incurred, though the work itself would not be expected to produce direct revenue. This conlusion is arrived at by a careful consideration of the evidence adduced before the commission, by which the commissioners feel they must be guided, such evidence in their minds greatly preponderating in favor of the extension of this important work in the manner indicated."

The favorable report of the commissioners, coupled with the announcement that the government, if sustained, would prosecute the work to completion, did excellent service in the general election immediately following. The Conservative government was sustained, and a solid body of government supporters from the Trent canal country were returned. A deputation several hundred strong proceeded to Ottawa to enforce their mandate by obtaining a definite assurance of the completion of the work. A government appropriation was now made, surveys were begun, and in 1894 two sections were placed under contract, followed by a third section in the succeeding year. Tenders were called for still another section, and several new surveys of additional portions were made during the past summer.

Everything looked favorable for the speedy completion of the Trent canal by a government fully committed to the great enterprise; but on June 23, 1896, one of those events occurred that frequently interfere with the plans of all governments. After a tenure of office of nearly two decades, the conservatives were defeated, and a new government took charge of the country's affairs, not committed in any way to the construction of the Trent canal, or indeed favorably disposed towards the project. Its first act in reference to this work was to withdraw the contract for which tenders had been asked, and to stop the surveys of all new sections. The sections under contract will be completed, but the further extension of the work at the present time depends upon a future decision, to be based, it is declared, upon two points: (1) whether the Trent canal is an actual necessity; (2) whether the financial condition of the country would justify the expenditure, if its construction be found advisable.

In accordance with this declaration, the new minister of railways and canals, Hon. A. G. Blair, made a personal examination of the route, and the work under construction, during the past autumn, in order to be able to lay the matter intelligently before his colleagues; and there the matter rests at present.

Having glanced at the political history of this government under-



MAP AND PROFILE OF THE TRENT CANAL.

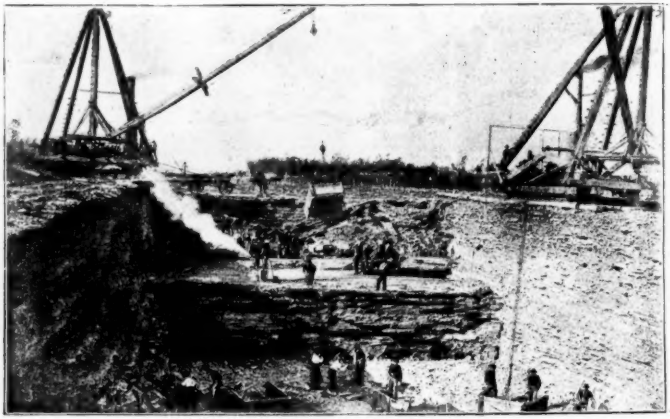
taking, we will now briefly examine the chain of lakes and rivers which the Trent canal location follows through Ontario, the extent of the work already completed, and the amount yet to be performed.

Reference being made to the heavy line on the above plan which indicates the Trent canal, it will be observed that the latter begins at Waubaushene on Matchadash bay, the most easterly extremity of Georgian bay. Midland, ten miles to the west, the terminus of a branch of the G. T. R., affords excellent harbor accommodation at the entrance. Two routes have been surveyed from this point to Lake Simcoe, between which bodies of water there is a difference in elevation of 136 feet. The first is an almost direct line to Orillia, to be obtained by cutting a canal 13 miles long. The second follows

ON THE SEVERN RIVER. ENGINEERS WORKING ON THE CANAL SURVEY.

the winding of the Severn river, with high, rugged banks, swift rapids, and numerous lake expansions. The country is partially wooded, and the scenery for the most part picturesque and wild. The river route was surveyed during the past summer, and a group of excellent scenic views taken during the progress of the work.

From Orillia the route crosses the northerly part of Lake Simcoe to the mouth of the Talbot river, a navigable stretch of 16 miles. This great inland lake is surrounded by an excellent farming community, with the thriving towns of Barrie and Beaverton upon its borders. The valley of the Talbot river is thence followed in the ascent to Balsam lake, as far as Kirkfield, little or no work being required for the first few miles, on account of the possibility of flooding



CONSTRUCTION WORK ON THE TRENT CANAL.

the narrow valley. This section was withdrawn from contract when the present administration came into power. From Kirkfield to Balsam lake a canal is under construction, principally through a limestone formation.

Mr. Onderdonk, the well-known contractor, has the heavy rock excavation nearly completed on this section. The distance from Lake Simcoe to Balsam lake is 20 miles, and the rise in elevation 122 feet. This section is known as the "height of land" or summit-level of the Trent canal route. Balsam lake, the highest water-level, about five miles wide and eight miles long, with its northerly arm, Gull river,

ROCK CUTTING, BALSAM LAKE SECTION, TRENT CANAL.

extending far back into the lakes of Haliburton, is connected with Cameron's lake by the Rosedale river, a narrow, shallow stream, where considerable work is being done in straightening the course and deepening the rocky bed.

Cameron's lake is somewhat smaller than the former, and has a feeder in the Burnt river, a stream of considerable size extending into the northern timber regions. The descent of 36 feet from Cameron's lake to Sturgeon lake is overcome by locks at Fenelon falls,—a modified Niagara. Here the River Scugog extends twenty miles to the south to Lake Scugog, passing through the prosperous towns of Lindsay on the river and Port Perry on the lake. A lock has been constructed at Bobcaygeon, giving access to Pigeon, Buckhorn, and Chemong lakes. From thence the lock at Buckhorn leads to Deer bay, while those at Love Sick and Burleigh give access to Stony lake, the total fall being 32 feet between Sturgeon and Stony lake. Thence free access to Clear lake is possible. Lakefield, at the southerly extremity of Clear lake, the end of the navigable waters of this section, is 66 miles from Balsam lake. The several very excellent locks and dams on this important section were all built prior to 1890.

The Otonabee river connects Clear lake with Rice lake, passing through Peterboro, the chief town of the Trent canal district and the headquarters of canal construction and operation. The fall of the Otonabee river in its course of ten miles is 155 feet. On account of the numerous rapids and the important riparian rights along its course, the canal location was made, for the most part, beyond the banks of the river.

It is divided into two sections, on each of which construction is far advanced. Earth and rock excavation, locks, dams, bridges, entrance piers, etc., are well under way, and the work will be practically completed during the present year. Rice lake, twenty miles long and two miles wide, is entered from the Otonabee river by a lock, while another, at its outlet at Hastings, gives access to the final stretch of water of this system,—the Trent river,—from which the canal derives its name.

This "reach" is navigable to Heeley's falls, a distance of fifty-four miles from Peterboro. The succeeding twenty miles of the Trent river, passing through the town of Campbellford, has a descent of 243 feet in its winding course. The canal location leaves the river at Heeley's falls, and, running in a south-easterly direction for eight miles, intersects Hoard's creek at a point four miles above its outlet into the Trent river, at Chisholm's rapids. No work as yet has been done on this section. At Chisholm's rapids there is a dam, a canal half a mile long through continuous rock, and a splendid lock, all

constructed sixty years ago. The river is navigable from the latter point to the town of Frankford, five miles below, where a dam likewise has been constructed. From thence to Trenton on the Bay of Quinte, a distance of seven miles, the river rushes down in a serpentine course, enclosed between high banks with many beautiful cascades. The descent from Frankford to the lake level in the Bay of Quinte is 118 feet.

The writer was engaged in making surveys and plans of fourteen miles of the section between Trenton and Chisholm's rapids during the past year. This section is now about ready for contract, and the district is anxiously awaiting the action of the government in reference to the continuance of the work.

The total distance from Georgian bay to Trenton along the Trent canal route is 204½ miles, of which 146 miles are navigable. Of the unnavigable portion the three sections under contract are about 16 miles long, leaving a balance of 43 miles to be rendered navigable by canals, locks, and dams. From Trenton there are two outlets to Lake Ontario,—one by the Murray canal, 10 miles to the west, the other down the charming Bay of Quinte, 80 miles to Kingston, at the head of the St. Lawrence river. From Kingston to Montreal the distance is 168 miles, making a total from Georgian bay to Montreal of 452 miles.

The cost of the Trent canal has been variously estimated at from two and a half million to ten million dollars. A mean between these two extremes, in the absence of definite data, in all probability, is somewhere near the mark.

A channel 50 feet wide and of sufficient depth to afford a 6-feet draught of water over the miter sills of the locks is being made on this canal. The new locks are being built entirely of concrete, in the proportions of 3½ cubic feet of Portland cement, ¼ cubic yard of sand, ½ cubic yard of screened gravel, and 1 cubic yard of broken stone of two-inch cubes as a maximum. The locks are 142 feet in length between the quoins, and the inside width at the floor level is 33 feet. There is no doubt that a 6-feet draught is entirely too small to render the canal serviceable for more than the requirements of the ordinary local traffic.

As Canada has been enlarging canals for a quarter of a century from a 9-feet to a 14-feet draught, it is to be hoped that the new administration, if it decides to prosecute the Trent canal to completion, will see the necessity of departing from the original 6-feet draught system of the Rideau and Trent canals, and of adopting one at least equal in capacity to the outlet—that is, to the St. Lawrence river canals.

The Trent canal route is 247 miles shorter than the Welland canal route from Lake Huron to Montreal, and 400 miles shorter than the Erie canal route from Lake Huron to New York. It is claimed that the present rate of eight to ten cents a bushel for marketing grain from the interior of Ontario could be reduced about one half. It is also claimed that the present seven-cent rate from Fort William to Montreal, for wheat, *via* the Welland canal, could be reduced very apppreciably by the Trent canal, owing to the shorter distance and the greater security of the inland waters, rendering insurance and other expenses considerably lower. Chicago and Duluth, too, would be enabled to utilize the Trent canal to excellent advantage for their foreign exports, were the latter made of adequate size to accommodate the propellers and barges of the upper lakes. The opening of this alternative Trent canal route would certainly lower freight rates generally, both by water and rail, from the granaries of the great northwest, and thus materially benefit the western agriculturalists, either directly or indirectly, by enabling them to obtain better prices for their products in the markets of the world than have obtained in the past.

Since adequate transportation facilities from the Great Lakes to the seaboard are of paramount importance to the prosperity of millions of people contiguous to the vast inland basin of the North American continent, where nature has nearly completed a navigable route, surely the adjacent progressive countries, with interests almost identical, could make the Trent canal route, the Erie canal route, or, best of all, the Welland and St. Lawrence canal route, a highway adequate to the future traffic demands of both countries.

A spirit of friendship and the application of ordinary business principles would certainly lead to the adoption of an international waterway project, upon which millions of dollars might be expended with the proud satisfaction of knowing that not a dollar was being wasted. The time has come in the history of the United States and of Canada when some definite system, commensurate with the present and prospective demands of the carrying trade, should be constructed. The first step,—the appointment of a commission,— has already been taken. Many citizens of both countries are awaiting the result, hopeful of definite action upon the reports with the least possible delay.

THE VEXED QUESTION OF GARBAGE DISPOSAL.

By Rudolph Hering.

WHEN I acceded to a request to contribute to THE ENGINEERING MAGAZINE an article on the above subject, I expected the early appearance of some reports which are being prepared on an extensive series of experiments made in Europe. These reports have been delayed for many months, and even now the time of their issue is uncertain. This article must, therefore, be confined to a discussion of the present status of the subject, leaving a description of the late European experiments for another article.

Several years ago the American Public Health Association appointed a committee to clear up the subject of the disposal of garbage and refuse, inasmuch as there were great differences of opinion regarding the best methods of disposal. The final report of this committee has not yet been issued. It is being delayed for the purpose of embodying the above-mentioned reports.

The work of this committee has been to obtain information regarding the present methods of collecting and disposing of garbage. Circulars were sent to nearly two hundred cities, and replies were received from about one hundred and fifty. The replies, in most cases, have naturally been incomplete. In order to answer some of the questions, it would have been necessary to make special investigations, which could not be expected. The information which the committee obtained, nevertheless, constitutes a very complete record of the present status of the question in this country, including also the opinions of various health officers and others who have sent replies. From year to year the results have been reported to the Association. The present article contains the sum of these reported results, and, also, a reference to those gained in Europe.

If the disposal of garbage and refuse is to be considered satisfactory in any city, it must be so from an economical, as well as from a sanitary, standpoint. Regarding the sanitary question, it should be said that no evidence reached the committee indicating a serious effect upon the health of those engaged in the work, either in the collection of the refuse, in picking it over, or in finally disposing of it. The writer, in examining a refuse station in the heart of London, saw a large number of women and children engaged in picking over the refuse, and was told that no unusual sickness among the employees had ever been re-

ported. In fact, there was a great desire to obtain an appointment at the works, and many applicants were on hand when a vacancy occurred.

Nevertheless, it is true that such works, unless very carefully managed, may become a nuisance to the neighborhood. It also seems at least probable that filth and street-sweepings in which disease-germs are harbored may sometimes reach the garbage and refuse depository, and thereby communicate disease. A satisfactory disposal of this material must therefore embody the destruction of infectious matter.

The economical question is of much practical importance. Unless a satisfactory disposition of garbage can be accomplished at a reasonable expense, it is not likely that all cities will at once adopt it. There are, in fact, many cases where the method of disposal is not determined by the city. It often awards a contract to the lowest bidder, and, in doing so, adopts the system recommended by him.

In order to appreciate the import of the experience gained in different cities, it was necessary at first to ascertain the true meaning of the designations given to this refuse in different parts of the country. The committee defined the term garbage as follows:

"By the term garbage is meant animal and vegetable waste—matter subject to rapid decay, from kitchens, markets, slaughter-houses. etc., but not including night soil and street-sweepings. By the term dry refuse is meant the miscellaneous material comprising the dry waste-matter from houses, stores, factories, and streets, such as ashes, paper, straw, wood, rubbish, etc."

In some of the southern States the term garbage is sometimes applied to dry refuse, and also to a mixture of dry refuse with animal and vegetable waste. The word "swill" is used commonly in New England to distinguish kitchen waste, while in Pennsylvania the word "slop" is applied to this material.

A discussion of the disposal of garbage is made difficult in our country by the lack of an analysis of the material. There are but few cities where a record could be obtained regarding its composition. It differs sometimes materially, not only in different cities, but in a single city. In the business part, for instance, the character will differ from that in the residence districts, and in each case it varies with the size of the city and with the season.

Where the kitchen refuse alone is considered, the moisture, or water contained in it, is much greater than where this refuse is mixed with ashes or general rubbish. On the average, we may say that garbage without dry refuse contains from sixty to eighty per cent. of water. We may further say that the animal and vegetable matter form about twenty per cent. of the combined garbage and dry refuse of a town. The quantity of grease contained in garbage has been found to vary

from two to four per cent. Where garbage is cremated, the ashes constitute about five per cent. of the original mass.

Until more information is at hand regarding the composition of garbage and dry refuse, it will be difficult in a general way to determine the most economical and sanitary method of disposal. The various methods now in use in one hundred and fifty American cities are:

Filling in or plowing into land, in 46 cities;

Dumping at sea or into a large river or lake, in 14 cities;

Feeding to animals, in 43 cities;

Reduction to grease and fertilizer, in 17 cities;

Cremation, in 30 cities.

Some cities use two methods of disposal, but credit is here given only to the principal or the more satisfactory one.

Filling into or dumping upon waste land is naturally inexpensive, and is, therefore, a more common method of disposal than it should be. Plowing into land, with the expectation that the manurial value of garbage will be utilized, is more expensive, and only one city has adopted this method exclusively. There is no assurance, in most cases, that at some future time, when the ground is used for building purposes, this organic refuse, in its partially-decayed condition, will not cause serious trouble. Such a method, therefore, is dangerous and improper.

Dumping at sea or into a large river is not objectionable when the material is effectually removed by the current. Some of it serves as food for fishes, and some is deposited. There are instances where this method is entirely unobjectionable. Where the garbage drifts ashore, or tends to fill up the river-bed, of course it cannot be permitted.

Feeding animals with garbage is common in New England, and generally in small towns throughout the country. When the material is fresh,—that is, not more than one day old,—and consists only of rejected or surplus food materials from kitchens, no danger results, and the economical value of the nutriment may be safely realized. But in large cities it is almost impossible to prevent a pollution of the material by dangerous substances, or premature decomposition, before disposal. In Massachusetts and Pennsylvania, evidence has been produced showing that garbage-fed pigs have been less healthy, and more frequently affected with trichinosis, than those which were given better food. Therefore, as a common method of disposal in large cities, this one should not be defended.

Reducing garbage to grease and fertilizer has been practised in this country for a number of years. It has been developed by several companies, operating different processes, the more prominent of which are known as the Merz, Simonin, and Arnold systems. In the first two

naphtha is added to the garbage, which dissolves and extracts the grease contained in it, leaving the remainder in a condition to be used as a filling or diluting material for a better class of fertilizers. In the Arnold process the garbage is boiled sufficiently long to extract the grease and water, which are subsequently removed by heavy pressure, and leave, as in the other systems, a material available as a fertilizer.

From a sanitary point of view, it may be said that the reduction method allows the garbage to be subjected to so high a degree of heat that any matter dangerous to health will be destroyed thereby, if the work is carefully done. In the operation of nearly all such works it is found, however, that the economy does not allow of sufficient care to prevent occasional offensive odors from creating a nuisance in the neighborhood. Complaints have been made in nearly all such cases, and in some cities reduction works have either been abandoned, or removed to a safe distance.

The advantage claimed for reduction works is the destruction of the garbage, and at the same time the securing of a profit from the manufacture of grease and fertilizer. If the prevention of a nuisance is insisted upon by the authorities, the profit is materially diminished, and in some cases has been entirely extinguished.

Owing to the economical necessity of having a large plant, the reduction method has never been extensively operated except in large cities, the principal ones being Providence, New York, Brooklyn, Philadelphia (in part), Buffalo, Cincinnati, Detroit, Milwaukee, St. Louis, and New Orleans. In some of these cities it has given considerable trouble and dissatisfaction, and in two of them the works have been abandoned, because their proper operation was too costly. During late years the prices of garbage grease and fertilizer have fallen materially, and the profits have been correspondingly diminished. The grease was formerly sold at three cents per pound; to-day it brings about one and half cents per pound. The fertilizer has similarly fallen in price. Probably the best reduction plant to-day is that situated on Barren island, where the garbage of New York and Brooklyn is being treated by boiling, the grease being subsequently extracted by pressure. Whether this plant can be profitably operated for the contract term of five years without causing a nuisance remains to be seen.

The cost of the reduction process has varied considerably in the different cities. The returns show a variation of from 10 cents to 67 cents per capita, excluding the cost of the disposal of dry refuse.

The cremation of garbage, or its destruction by fire, is practised more particularly in small cities, although Montreal, Washington, Atlanta, Philadelphia (in part), Allegheny City, and Wilmington, Del., also use it. The method seems to be growing in favor in this

country. In Europe it is, and has been for many years, considered the only one giving satisfaction in both large and small cities, wherever garbage has been subjected to any treatment.

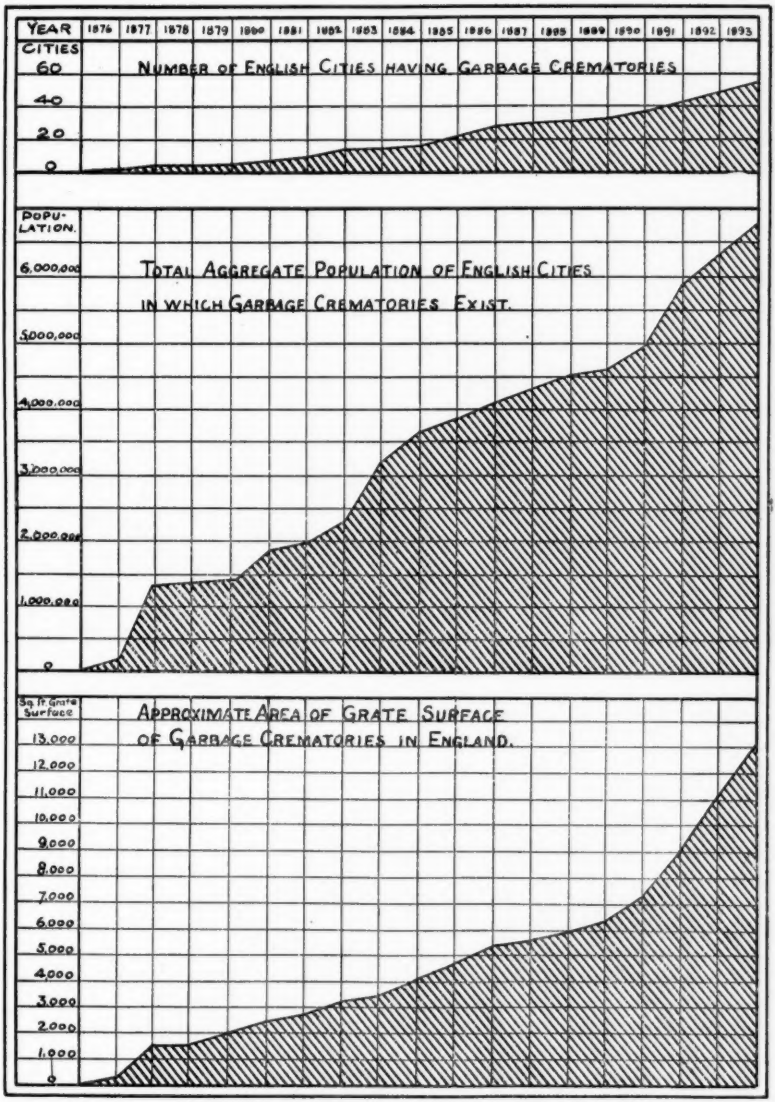
Cremation is accomplished in furnaces, of which there are a number of designs in use. The Engle, Dixon, Brown, and Thackeray furnaces are the principal ones used in America. In Europe the Fryer, Warner, and Horsfall furnaces are the most common. These crematories, furnaces, or destructors (as they are called in England) differ more or less radically in their design. The English destructors generally have a grate surface of about twenty-five square feet. The garbage is fed upon the grate by gravity down an inclined plane, in such a manner that it allows the material gradually to become thoroughly dry before it reaches the grate. The Thackeray furnace, as erected in Montreal, is an imperfect imitation of them. The differences between the English furnaces themselves are found principally in the details of firing, draft, and feeding.

The American furnaces have larger grates. They average from 5 to 6½ feet in width, and from 12 to 20 feet in length. The garbage is dumped directly upon the grate bars from openings at the top, in its fresh state, without previous drying, and is spread out over the bars and raked from below.

In Europe it has been generally found that the garbage and dry refuse (which are mixed and destroyed together) will be consumed without the addition of coal or other fuel. In the American furnaces the addition of such fuel has been found necessary in every case. For this reason, and also on account of the larger experience of the men, who generally hold such positions for life, it is found that the cost of cremation in Europe has been much less than in America. In some cities steam is generated by the fires, and the power thus gained, by being utilized for various purposes, has reduced the cost of destruction. In Montreal, it is stated, the furnace erected after English patterns has not required any coal for the destruction of the refuse.

The fact that the English furnaces are giving much more economical results is probably due also to the fact that the garbage is delivered to the grate with much less moisture and mixed with the dry refuse of the town, which consists largely of unburned coal, wood, paper, straw, and sometimes also street-sweepings, etc., much combustible material being thus added.

A large amount of fine ashes will clog the fires and reduce the draft and combustion, so that in many instances it has been found necessary to first sift out the fine ashes. These are used for filling and for other similar purposes. Whatever organic matter passes the screens and mingles with the fine ashes, although it is found in some cases to



GRAPHICAL TABLE SHOWING PROGRESS OF GARBAGE CREMATION IN ENGLAND.

be as much as fifteen per cent., does not become objectionable, probably on the same principle that earth-closets will take up even a much greater percentage of organic matter without causing a nuisance.

The greatest objection to the burning of garbage is due to odors arising from imperfect combustion. To prevent this it is necessary either to use great skill in attending the fires, which can be attained only by long practice, or to pass the fumes from the furnace through a special fire and thoroughly burn them before they pass up the chimney. The latter expedient is used, when necessary, in most of the English furnaces, and adds slightly to the cost. Some of the American furnaces have a like provision. Another objection to garbage cremation is the escape from the chimney of fine dust which settles upon the neighboring ground. To prevent this a part of the main flue is usually widened into a good-sized chamber, so that the current is slackened, and the dust deposited and subsequently removed.

The annual cost of garbage-disposal by cremation in the United States is found to vary from three to six cents per capita in large cities, and from six to ten cents per capita in medium-sized cities; in one small city the figure reaches twenty cents. The cost of refuse-destruction by fire in Europe is very slight in most cases, and in some there is even a profit obtained by the production and utilization of steam.

To show the growth of garbage-cremation in England, which is almost the exclusive method used in that country, I append a graphical table which explains itself and will be of interest in showing the evident satisfaction with the results.

The present article may be closed with the conclusions reached in a late report made by certain city officials of Zurich, Switzerland, after having visited the best works of Europe, and made experiments with the material collected in their own city. They say:

"Destruction of refuse by fire is to be recommended. This method will not entail a greater expense than the more crude methods used heretofore. With the latest improvements and with careful management, no objectionable results will follow in the immediate or more distant surroundings of the garbage furnaces. From a sanitary point of view, cremation is the only correct method of disposal, particularly during epidemics. This method secures invaluable service by including, with the material to be cremated, dust and the sweepings from buildings and public streets. During ordinary times this process is also beneficent, because it does away with the accumulation of the more or less objectionable matter which otherwise must be dumped in the neighborhood of habitations. The slight and sometimes questionable value of the refuse for fertilizing purposes should not be placed against the much greater value of better sanitation."

EPOCH-MAKING EVENTS IN ELECTRICITY.

By G. H. Stockbridge.

III.—ARAGO—THE BEGINNINGS OF MAGNETO-ELECTRICITY.

FOR a long series of years, beginning with the date of its foundadation in 1816, the French journal, *Annales de Chimie et de Physique*, had for its editors Joseph Louis Gay-Lussac and François Jean Dominique Arago, two of the most eminent physicists in the world. This journal was accustomed to publish, besides many extended scientific papers, abstracts of the proceedings of the French Royal Academy of Sciences, of which both editors were members. In its report of the Academy's meeting of November 22, 1824, the following notice appeared: "M. Arago verbally communicates the results of some experiments which he has made concerning the influence exercised by the metals and many other substances upon the magnetic needle, which influence results in rapidly diminishing the amplitude of the oscillations without sensibly altering their duration. He promises a detailed memoir on this subject."

The same periodical, in the course of its account of the Academy's meeting of March 7, 1825, makes the following statement: "M. Arago brings to the attention of the Academy apparatus which shows in a new form the action which magnetized bodies, and those that are not magnetized, exercise upon each other.

"In his first experiment (see the number for December, 1824, page 363) M. Arago had proved that a disc of copper, or any other substance, solid or liquid, placed below a magnetic needle, exercises upon this needle an action whose immediate effect is to alter the amplitude of the oscillations, without sensibly changing their duration. The phenomenon with which he has entertained the Academy today is, so to speak, the reverse of the former. Inasmuch as a moving needle is arrested by a disc at rest, M. Arago has thought it would follow that a needle at rest would be drawn along by a moving disc. If a copper disc, for example, is rotated with a definite speed under a magnetic needle, enclosed on all sides in a closed vessel, the needle does not place itself in its ordinary position. It comes to rest outside the magnetic meridian, and, indeed, the farther from this plane, the more rapid the rotary movement of the disc is. If this rotary movement is sufficiently rapid, the needle, at any distance from the disc, turns, itself, continuously about the filament from which it is sus-

pended. We shall in the near future report upon the laws of these singular phenomena."

These two brief notices travelled in the usual course to Germany, where they at once engaged the attention of Seebeck and Pohl; to Switzerland, where Prevost took up the investigation; to Italy, where Nobili and Bacelli made experiments upon the subject; and to England, where Herschel, Babbage, Christie, and Harris brought the matter before the Royal Society, with much experimental detail, and much discussion of the theory. Additional interest was given to the study of the subject in England—if, indeed, the study was not thus initiated—by a visit which Gay-Lussac made to London in the spring of 1825, during which the celebrated French physicist delighted his British *confrères* by enlarging upon this latest bit of scientific news. Far more entertaining it was to some of them, we may believe, than the reports of the Turkish investment of Missolonghi, which were circulated about the same time. And a Philistine public, which often wonders at the enthusiasms of science no less than at those of art, may, even in these days when the sentimental interest in the Grecian struggle with the Turks is renewed at its old height, be brought without misgivings to face the question whether these scientific enthusiasts of 1825 had not ample justification for their preference. True, Greece had to be freed, and the Turk must eventually —however far in the future—be thrust out of Europe for the protection of Christendom and the good of the race, but other things were no less imperative. If we were ever to have Niagara for our bondman, with all which that promises; if we were to have the electric light and electric power in their present state of development, and with the advances that seem to be at hand; if we were to have that enlargement of our knowledge of nature, whose meaning is only now beginning to unfold,—it needed that these men should have faith in their predominant instinct, and should try first of all to find out what nature meant by letting a non-magnetic disc cause the rotation of a magnetized needle, just as if it were itself a magnet.

At least, that was what the phenomena seemed to indicate. Duhamel, according to Arago, was the first to put the magnetic theory into formal statement, though Arago also declares that the theory was not absent from his own mind at the time when he made the first disclosure of his discovery to the Academy. For some reason Arago withheld the statement of it, and contented himself with the promise, as we have seen, of a theoretical explanation later. His first utterance of that kind was contained in a paper replying to certain of his critics, and discussing the theories put forth by the philosophers who took up the theoretical investigation long before Arago was ready to ful-

fill his promise. Even in this paper, which was read to the Academy July 3, 1826, Arago is more concerned to deny that Barlow's experiments with an iron sphere rotating near a magnetic needle were genuine anticipations of his own experiments, either in point of date or in principle, than to set forth a working theory of what he had done.

I have been unable to find the passages in *Brewster's Journal* which aroused Arago to prepare this vindication, but their character is well enough indicated by Arago himself, and his reply is passionate as well as conclusive. It appears that Sir David Brewster, in some one of the many scientific publications with which his name is identified, had, in April, 1826, claimed for his countrymen the original discovery of the "magnetism of rotation," and had further declared that, "with the exception of a small number of important experiments made in France, it had been exclusively followed up by the members of the Royal Society." By Brewster's account, then, it was Barlow who discovered the "magnetism of rotation," and it was the British school of physicists that had pursued the inquiry than which—still according to Brewster—"few branches of modern science deservedly excite a more lively interest." Brewster overlooked the fact that Arago's work was anterior to Barlow's, as well as the radical differences between the two types of experiment, and he appears to have been totally unaware, in the usual British way, of the investigations of the German, Swiss, and Italian philosophers whose names have been rehearsed above. Yet Herschel and Babbage, whose theoretical studies Brewster must chiefly have had in mind, had set up their apparatus in Babbage's house to repeat and enlarge Arago's experiments, not Barlow's, and their theory of the reactions was based mainly on their study of the French *savant's* work. There was ample justification, it would seem, for Arago's heat in denouncing Brewster for disregarding his well-grounded and well-known prior claims.

Strangely enough, the explanation of the phenomena given by nearly all the philosophers was false as to Arago's discovery and true as to Barlow's. By pure accident the targets were so arranged that whoever missed the first would be sure to hit the second. The accepted statement of the theory is that presented by Herschel and Babbage to the Royal Society. Briefly stated, their conception of the action is that the pole of the magnetic needle causes an opposite pole in the nearest part of the copper disc, and that a diffused polarity of the same kind surrounds the induced pole. The disc, in being rotated, is supposed then to acquire and lose its magnetism, not instantly, but in a sensible period. Accordingly there will always be an

attractive force tending to advance the needle in the direction of the disc's rotation. Now, this agrees perfectly with what happens when a disc or sphere of iron is the rotating body. But neither Arago or Ampère could discover the presence of any induced magnetism in the copper disc, and they were even convinced by special experimentation that the action was one of repulsion. The way matters stood was that the current theory was inconsistent with the observed facts, and yet neither the originator of the experiments or any other physicist was prepared to advance a more consistent explanation.

The solution came in a roundabout way. Michael Faraday, perhaps the most brilliant of the great minds that have chosen electricity as their field of research, made public in November, 1831, the results of his attempts to obtain electricity from magnetism, and, in doing so, he described how, by suddenly creating a magnet in the neighborhood of a helix connected with a galvanometer, or by causing a relative movement between magnets and helices so connected, he could generate electricity, as shown by momentary deflections of the galvanometer needle. Magneto-electric induction being once proved in this manner, it flashed upon the mind of its discoverer that the phenomena of Arago's disc were now explicable under a new hypothesis. Arago's magnetic needle remained a source of induction, but, instead of inducing magnetism in the copper disc, it induced electric currents. To Faraday himself it was a complete surprise. He simply found that the same key which had unlocked the larger chamber opened the door of the room into which Arago had stumbled. It seems fitting to give a somewhat long extract from Faraday's account of the matter.

"The momentary existence of the phenomena of induction now described," he says, "is sufficient to furnish abundant reasons for the uncertainty or failure of experiments hitherto made to obtain electricity from magnets.

"It also appears capable of explaining fully the remarkable phenomena observed by M. Arago between metals and magnets, when either are moving, as well as most of the results obtained by Sir John Herschel, Messrs. Babbage, Harris, and others, in repeating his experiments, accounting at the same time perfectly for what at first appeared inexplicable,—namely, the non-action of the same metals and magnets when at rest."

Assisted by Mr. Christie, Faraday took a magnet made up of about four hundred and fifty bar magnets, "each fifteen inches long, one inch wide, and half an inch thick, arranged in a box so as to present at one of its extremities two external poles. To concentrate the poles and bring them nearer to each other, two iron or steel bars,

each about six or seven inches long, one inch wide, and half an inch thick, were put across the poles," so as to be adjustable to and from each other.

"A disc of copper, twelve inches in diameter, and about one fifth of an inch in thickness, fixed upon a brass axis, was mounted in frames, so as to allow of revolution either vertically or horizontally, its edge being at the same time introduced more or less between the magnetic poles. The edge of the plate was well amalgamated for the purpose of obtaining a good, but movable contact, and a part round the axis was also prepared in a similar manner.

"Conductors or electric collectors of copper and lead were constructed so as to come in contact with the edge of the copper disc, or with other forms of plates hereafter to be described. These conductors were about four inches long, one third of an inch wide, and one fifth of an inch thick; one end of each was slightly grooved, to allow of more exact adaptation to the somewhat convex edge of the plates, and then amalgamated. Copper wires, one sixteenth of an inch in thickness, attached, in the ordinary manner, by convolutions to the other end of these conductors, passed away to the galvanometer.

"The galvanometer was roughly made, yet sufficiently delicate in its indications. The wire was of copper, covered with silk, and made sixteen or eighteen convolutions. Two sewing-needles were magnetized and fixed on to a stem of dried grass parallel to each other, but in opposite directions, and about half an inch apart; this system was suspended by a fibre of unspun silk, so that the lower needle should be between the convolutions of the multiplier, and the upper above them. The whole instrument was protected by a glass jar, and stood, as to position and distance relative to the large magnet, under the same circumstances as before.

"All these arrangements being made, the copper disc was adjusted, the small magnetic poles being about half an inch apart, and the edge of the plate inserted about half their width between them. One of the galvanometer wires was passed twice or thrice loosely round the brass axis of the plate, and the other attached to a conductor, which itself was retained by the hand in contact with the amalgamated edge of the disc at the part immediately between the magnetic poles. Under these circumstances all was quiescent, and the galvanometer exhibited no effect. But the instant the plate moved, the galvanometer was influenced, and, by revolving the plate quickly, the needle could be deflected ninety degrees or more.

"It is difficult, under the circumstances, to make the contact between the conductor and the edge of the revolving disc uniformly good and extensive; it was also difficult in the first experiments to ob-

tain a regular velocity of rotation; both these causes tended to retain the needle in a continual state of vibration; but no difficulty existed in ascertaining to which side it was deflected, or, generally, about what line it vibrated. Afterwards, when the experiments were made more carefully, a permanent deflection of the needle of nearly forty-five degrees could be sustained.

"Here, therefore, was demonstrated the production of a permanent current of electricity by ordinary magnets.

"When a mere wire, connected with the galvanometer so as to form a complete circuit, was passed through between the poles, the galvanometer was affected; and, upon moving the wire to and fro, so as to make the alternate impulses produced correspond with the vibrations of the needle, the latter could be increased to twenty or thirty degrees on each side the magnetic meridian.

"The experiments described combine to prove that, when a piece of metal (and the same may be true of all conducting matter) is passed either before a single pole, or between the opposite poles of a magnet, or near electro-magnetic poles, whether ferruginous or not, electrical currents are produced across the metal transverse to the direction of motion; and which therefore, in Arago's experiments, will approximate towards the direction of radii. If a single wire be moved like the spoke of a wheel near a magnetic pole, a current of electricity is determined through it from one end towards the other. If a wheel be imagined, constructed of a great number of these radii, and this revolved near the pole, in the manner of the copper disc, each radius will have a current produced in it as it passes the pole. If the radii be supposed to be in contact laterally, a copper disc results, in which the directions of the currents will be generally the same, being modified only by the coaction which can take place between the particles, now that they are in metallic contact.

"Now that the existence of these currents is known, Arago's phenomena may be accounted for without considering them as due to the formation in the copper of a pole of the opposite kind to that approximated, surrounded by a diffuse polarity of the same kind; neither is it essential that the plate should acquire and lose its state in a finite time; nor, on the other hand, does it seem necessary that any repulsive force should be admitted as the cause of the rotation.

"But it is possible (though not necessary for the rotation) that *time* may be required for the development of the maximum current in the plate, in which case the resultant of all the forces would be in advance of the magnet when the plate is rotated, or in the rear of the magnet when the latter is rotated; and many of the effects with pure electro-magnetic poles tend to prove this is the case. Then, the tan-

gential force may be resolved into two others, one parallel to the plane of rotation, and the other perpendicular to it: the former would be the force exerted in making the plate revolve with the magnet, or the magnet with the plate; the latter would be a repulsive force, and is probably that the effects of which M. Arago has also discovered.

"The extraordinary circumstance accompanying this action which has seemed so inexplicable—namely, the cessation of all phenomena when the magnet and metal are brought to rest—now receives a full explanation; for then the electrical currents which cause the motion cease altogether."

The puzzling discovery which Arago made in 1824 or 1825, as we have seen, may be said to mark, rather than to make, an epoch. It recalls a period when scientific men the world over were seeking to generate electricity by the use of magnetism as a source. The experiments of Arago excited the deepest interest, but the disc remained a marvel rather than the origin of a great line of arts. The wonderful thing was in their hands, but they did not know what it was. If I may recur to the figure employed in the first of this series of articles, I may say that Volta, with his crown of cups, discovered the main land upon which all the later progress in galvanism or voltaism has been made; Oersted, with his moving needle responsive to the electrical currents, touched upon a peninsula which was afterwards shown to be connected with the main land by firm earth; while Arago hit upon an island, having the same constituent elements in its soil as the near-by land, but not connected with it. The arts of magneto-electric induction have a wide water-gap between them and Arago's island. So long as we waited for that to be the starting-point,—or at least until we had bridged the gap by discovering the true theory of the Arago phenomena,—there would have been no hope of advancing to the developments which we now know. In truth, the art remained for six years where it began, and then blossomed quickly into full expansion on Faraday's discovery of the true theory. There is, perhaps, no better illustration in all the arts of the importance of a right interpretation of nature, if we are to make her useful to mankind, than this barren experiment of Arago's, when compared with the fruitfulness of the subject as proved by the later intelligent development under a correct explanation of the things observed.

ENGINEERING PROBLEMS OF THE TALL BUILDING.

By Charles O. Brown.

FROM the earliest historic time men have built shelters in which to find protection from the elements. These consisted of walls and a covering over them. Doors were formed by two stones set on end, with a flat stone across the top. On general principles, there has been little change in four thousand years. We are doing the same thing to-day. But the value of lots has increased, and architecture, being prevented from extending sidewise, has been forced skyward. When buildings reached eight and nine stories, the question was asked: How will they stand up in a gale blowing one hundred miles an hour? Here we had reached the point where it would not answer any longer to simply pile up building stones; it had become necessary to use material of greater strength to stiffen the structure.

This step once taken, it was obvious that the conventional thickness of walls could be reduced, thereby adding to the net cubical contents, or renting-space, of the building, and the architect found it very convenient to be able to make his design almost regardless of the structural features, as the skeleton frame could be designed to suit his plans.

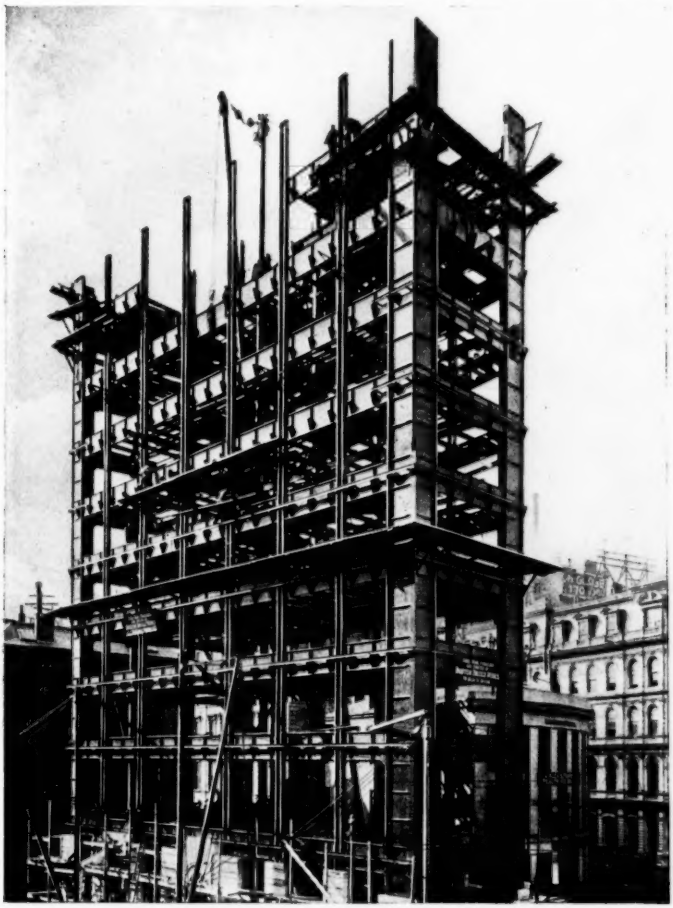
Engineering principles are few and simple. Archimedes said two thousand years ago: "Give me a lever and fulcrum, and I will lift the world off its hinges." So the engineer of to-day will solve any problem, if he is given the modern lever,—namely, money. The engineering problem involved in the construction of the modern sky-scraper does not present many new features.

A good bridge engineer requires but little additional knowledge to enable him to master the engineering work for buildings, and the New York *Sun*, when describing the new Manhattan Life Building about two years ago, very aptly headed the article "A Bridge on End."

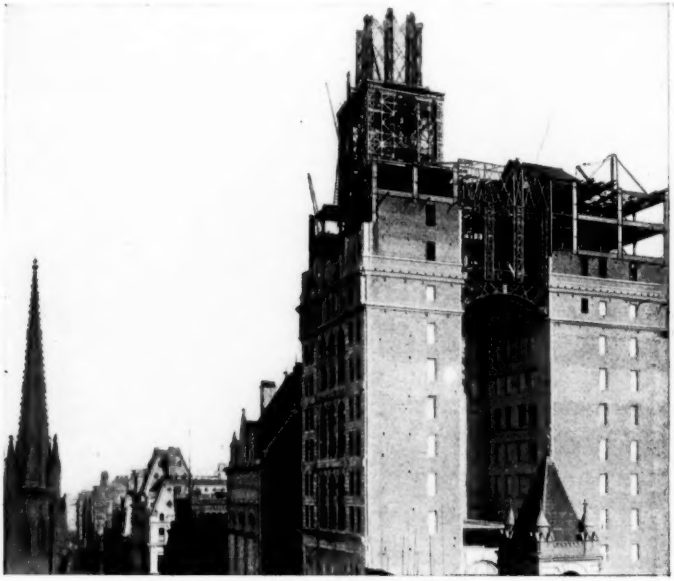
The data required by the engineer and furnished by the architect are: a survey of the lot and a general layout of the proposed building, together with a description of the material to be employed for walls, floors, roofs, partitions; also a report of the borings, showing the nature of the ground at different depths.

His work consists in the following: verification of the survey by comparing it with the actual dimension of the lot; computation of the dead load of the structure; determination of the live load for which the

building is to be designed, usually fixed by law; locating the columns, floor girders, and beams; computation of the strains produced upon each member of the skeleton by live and dead load; computation of the strains produced by a wind pressure of thirty pounds per square foot; the proportioning of all the members of the skeleton, so that the strains may not exceed the limits fixed by law; a careful estimate of the dead weight, to see that the assumed load is correct; the designing



THE SKELETON OF A SKY-SCRAPER. THE WORTHINGTON BUILDING, BOSTON, MASS.



THE MANHATTAN LIFE BUILDING, PARTLY COMPLETED.
Showing structural framing of the bracing across the light court and of the upper stories of main building and lower part of the tower.

of the foundation, which is usually carried to rock by means of pneumatic caissons. In doing this work the designer cannot give his ingenuity much latitude; he must keep within the somewhat narrow limits of the law. The building law of the city of New York has been considered a model, and undoubtedly buildings constructed under the same are safe; but, when applied to tall buildings, its provisions are too exacting, and involve unnecessary expenditure.

The live load of one hundred pounds for office-buildings, as fixed by law, is too high, and the requirement that each of twenty floors shall be figured for that load compels the engineer to proportion the lower columns for strains which in reality never exist.

The required thickness of curtain walls is also excessive. For a building three hundred feet high, they must be thirty-two inches in the lower stories. If the skeleton is capable of sustaining all the strains that may come upon it, and is properly protected against rust and fire, it should be left to the architect to say how thick a wall will form the required shelter and furnish a sufficient non-conductor to avoid rapid changes of temperature in the building.

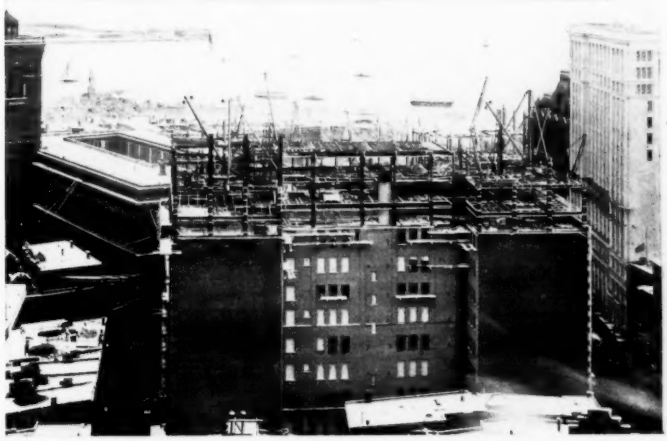
Realizing this fact, the superintendent of buildings called a convention consisting of representatives of all the building trades and of societies interested otherwise in buildings and real estate, which met in the winter of 1895-96. The work of revision was done by committees selected by the convention, and was nearly completed when the Greater New York commission decided to embody the old law, slightly modified, in the new charter, leaving the necessary revision for the municipal assembly. An extract from the report of the committee on formulas and calculations, as approved by the digest committee, which relates to the strength of materials, is appended to this article.

A few of the features recently adopted in building construction, and now universally used, are the following.

The Pneumatic Caisson, which, as used in the foundations for the Manhattan Life, the Standard Oil, and Empire Buildings, enables the engineer to go to rock without disturbing the adjoining buildings. This system has been used extensively for bridge work. The Brooklyn bridge piers are founded in the same manner.

Steel Columns, which have taken the place of cast-iron columns,—at least in cases where the columns may be subjected to bending strains.

Knee Bracing. To resist the wind pressure in bridge towers, diagonal bracing is used, but this, if applied to buildings, would interfere with door- and window-openings; hence knees are substituted. These knees produce bending strains on the girders and columns to which they are attached.

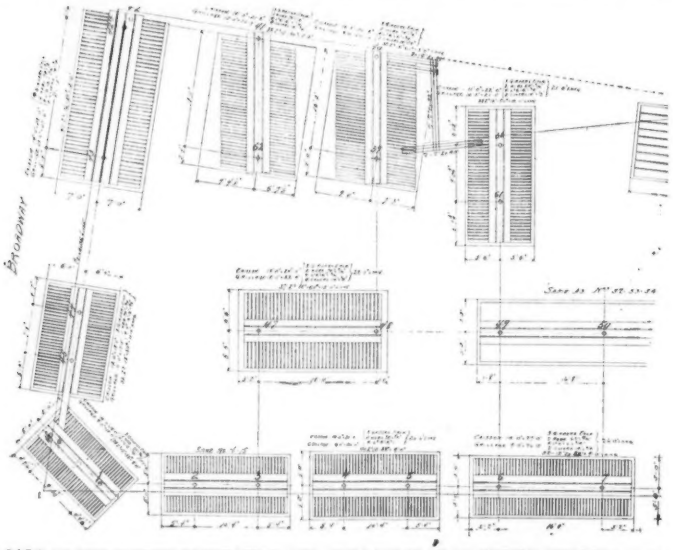


ADDING TO THE HEIGHT OF AN EXISTING BUILDING. LOWER BROADWAY, NEW YORK.

The Cantilever, used mainly in foundations. Columns on or near the party lines would exert an undue pressure along the edge of the foundations; to avoid this, they are placed on the overhanging arm of a girder, supported over the center of a circle, square, or rectangle of sufficient size to reduce the unit pressure to a safe limit, and located so as not to go beyond the lot line.

The Grillage. The old base for columns used to be a cast-iron plate about three inches thick, laid on granite. As loads on columns increased, it developed into large bed-castings up to ten feet in diameter and four feet in depth, provided with ribs and flanges. This is the mechanical limit in cast iron. Where the loads had to be distributed over still larger areas, the strength was obtained by two or more layers of steel beams or riveted girders, constituting a steel grillage, which, calculated on scientific principles, made it possible to dispense with the expensive granite cap-stones, and even with brick masonry, if desired, as the grillage can be placed directly upon a bed of concrete. Wooden grillage has been used for bridge-work for many years, but it was always designed by rule of thumb.

The question of greatest importance in connection with these costly buildings is the protection of the metal skeleton against corrosion and fire. Corrosion results from the combined influence of moisture and



PART OF THE CAISSON FOUNDATION AND GRILLAGE PLAN OF EMPIRE BUILDING, N. Y.

RAISING THE STANDARD BLOCK.
Showing the equalizing girders over the ninth story of the old building, and lower part of the skeleton framing for the new portion.

air upon the metal. If either of these is excluded absolutely, corrosion will not take place, provided no acids or other deleterious matters can come in contact with the metal.

Paints and coatings of all sorts are proposed. In the opinion of the writer, the best method is to thoroughly envelop all parts of the frame in Portland-cement masonry. For this reason the columns and girders should be constructed so that no hollow spaces remain, such as the interior of box-columns and girders. In bridge-work, where the metal cannot very well be surrounded by masonry, it has been the rule for twenty-five years to exclude all box sections, so that all parts may be at any time inspected and painted. Where cast iron may be used, the danger from rust is smaller, the interior of these columns being almost entirely free from its action.

Burned brick is accepted as the best protection against fire. Eight inches of it on the exterior faces of columns, four inches on the interior,

THE STANDARD BLOCK, NEARLY COMPLETE.

and two inches for the lower flanges of beams, are considered to be a sufficient protection.

On lower Manhattan non-fire-proof buildings are constantly being torn down and replaced by modern fire-proof buildings, and with each operation of this kind the danger from a general conflagration is diminished. Not all the modern buildings are erected with the greatest possible security against fire, but improvements in that direction are progressing steadily. Our fire-extinguishing apparatus is ineffective at a height of more than one hundred and twenty-five feet, and it would be well to restrict the use of inflammable material in buildings exceeding that height. Concrete floors are now extensively used, and the use of aluminum or other metal for windows, doors, wainscot, and trim would still further diminish the danger from fire.

The opinions on the fire-resisting qualities of various materials differ widely. Tests are generally made by interested parties desiring to show good results for their goods. It is hoped that the building commissioners of Greater New York will be empowered, and provided with means, to establish a bureau of tests, so that the true character of these materials may be ascertained by disinterested parties. The labors of such a bureau, if extended to the investigation of the

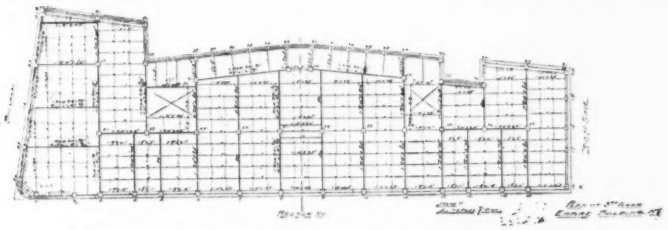
strength of other materials, would be of incalculable value to building interests.

A law limiting the heights of buildings should harmonize with sanitary necessity and artistic taste. From an engineering point of view the limit is fixed by the bearing capacity of the soil, or of the concrete medium when resting on rock.

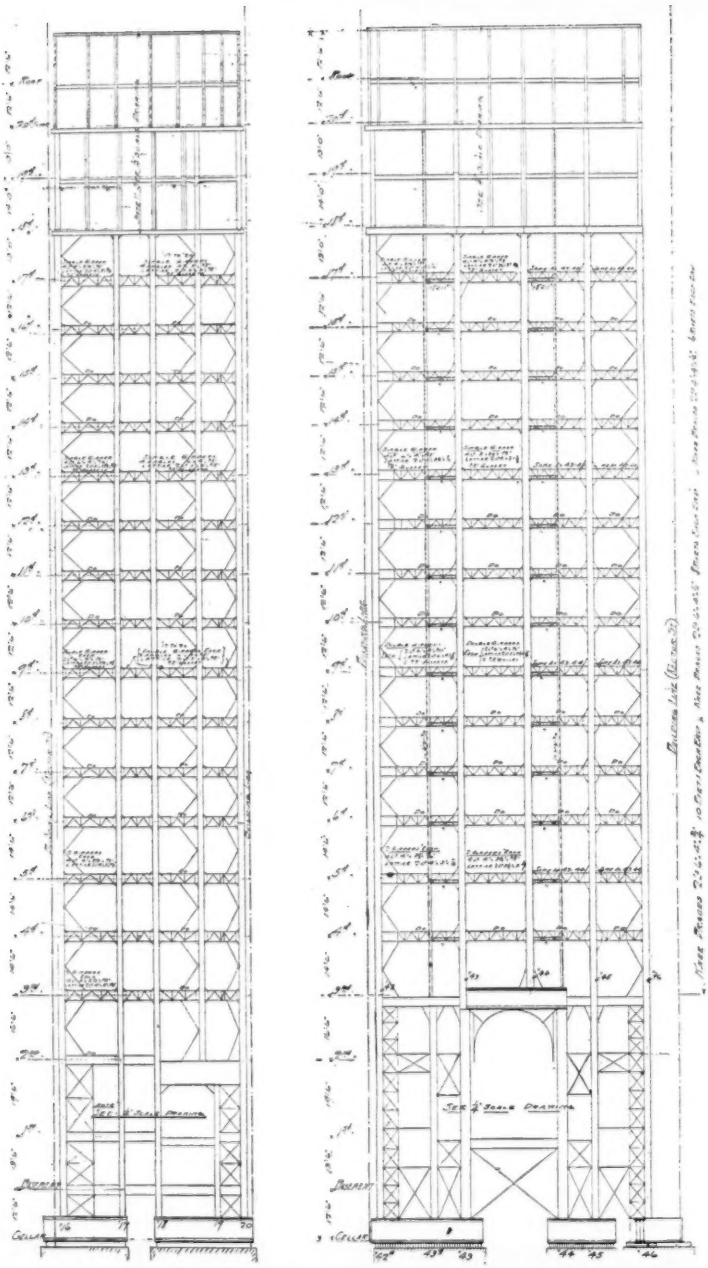
The Empire building, here illustrated, is to have twenty-one stories. It will have a concrete foundation resting on rock. This foundation covers about one-half the area of the lot. The weight on the foundation is not in direct proportion to the number of floors, but increases more rapidly with increased height, so that this building could not be made forty stories high on the same foundation.

From a commercial point of view the competition of these new tall buildings has been severe on the older and lower buildings, and has created a desire to add stories to the latter. This is usually impracticable, especially where the present structure is not of sufficient strength to carry additional weight. There are a few buildings, erected only a short time ago and designed with an excess of strength, which have been raised to obtain the additional renting-space. An illustration is the office-building of the Standard Oil Company, 24–26 Broadway. The problem was to add six new stories to a nine-story building. The solution of the problem was effected by an entirely new addition on the northerly side, having a frontage of twenty-six feet on Broadway and extending through to New street. The building was thoroughly examined in all its details. The actual diameters and thickness of shells of the cast-iron columns were measured; also the dimensions of all brick and granite piers. The plans of the pile foundation were at hand, and evidence was obtained that these plans were duly carried out.

Careful computation of live and dead loads for each supporting column, pier, and wall were made, and, upon comparing these loads with the actual strengths of the supports, it was found that they were generally sufficient to sustain the additional weight, especially if the



A TYPICAL FLOOR-PLAN. THIRD FLOOR OF THE EMPIRE BUILDING.



SKELETON FRAMING AND WIND BRACING OF A TWENTY-ONE STORY BUILDING; THE EMPIRE BUILDING, N. Y.

new loads were carefully distributed, and any local concentrations prevented. A system of lattice girders was designed, forming an immense cap for the old building, and at the same time a base for the new part. These lattice girders extended over the northerly wall, where they were supported by columns running down to new foundations in the extension. New lines of columns were also provided at the few points in the old building which were found deficient. These were made to extend from this system of equalizing girders down to the old foundation. In this manner it was possible for the company to increase the floor-space sixty-six per cent. with moderate cost. The accompanying illustration shows the system of equalizing girders.

The following extract is from the report of the Sub-Committee No. 14 on Formulas and Calculations, as approved by the Digest Committee. These provisions, if embodied in the building laws, would be a long step toward more scientific construction:

The dead loads in all buildings shall consist of the actual weight of walls, columns, floors, roofs, partitions, and all permanent construction.

The live or variable loads are to consist of all loads other than dead loads, and shall be assumed as follows:

Floors for dwellings, offices, and schools, 60 pounds per square foot.

Sleeping rooms, 40 pounds per square foot.

Floors for stables and carriage-houses, 65 pounds per square foot.

Floors for public assembly, 90 pounds per square foot.

Office-floors must be of sufficient strength to safely carry a concentrated load of 4,000 pounds at any point.

Floors for ordinary stores, light manufacturing, and light storage to be computed for not less than 120 pounds per square foot.

For warehouses and factories, not less than 150 pounds per square foot.

Floors constructed for the above loads shall not be used for heavier purposes, except upon permit obtained from the department of buildings.

For sidewalks, 300 pounds per square foot.

Floors for stores, warehouses, and factories must be of sufficient strength to safely carry a concentrated load of 4,000 pounds.

Any floors, or any portion of floors, in any building intended for heavier floor or concentrated loads shall be constructed to support the loads for which they are intended.

The live load on roofs with a pitch of more than 20 degrees shall be assumed at 30 pounds per square foot, measured on a horizontal plane. If the pitch is less than 20 degrees, the live loads shall be assumed at 50 pounds per square foot.

For columns, piers, walls, and other vertical supports in office-buildings, schools, dwelling-houses, and public assembly buildings, a reduction of the live load may be computed as follows: For roofs and top floors the full live load shall be used in the computation of the loads. For the next lower floor, 95 per cent. of the live load may be used. For the next lower floor 90 per cent. For every succeeding lower floor an additional 5 per cent. may be deducted, until 10 per cent. remains, when all succeeding lower floors may be computed for 10 per cent. of the live load established in this act. In computing footings for stores, warehouses, factories, and all buildings in which live loads may be considered as imposed for greater part of the time, 75 per cent. of the full live load only need be transferred to the footings.

For other buildings subjected mainly to the load of people, such as dwellings, office-buildings, hotels, and public assembly buildings, 20 per cent. only of the full live loads may be so transferred to the footings.

The strength of factory floors intended to carry running machinery must be increased above the minimum given in this section in proportion to the degree of vibratory impulse liable to be transmitted to the floor, subject to the approval of the superintendent of buildings.

In columns of compression members of cast iron, steel, wrought iron, or wood, the stress per square inch shall not exceed that given in the following tables:

When the length divided by least radius of gyration equals	Working stresses per square inch of section.		
	Cast Iron.	Steel.	Wrought Iron.
120		6,290	5,814
110		6,860	6,230
100		7,460	6,666
90		8,120	7,117
80	5,710	8,810	7,576
70	6,720	9,540	8,032
60	7,950	10,260	8,475
50	9,400	10,970	8,888
40	11,030	11,620	9,250
30	12,770	12,190	9,570
20	14,380	12,620	9,800
10	15,560	12,900	9,950

And in like direct proportion for intermediate ratios.

When the length divided by the least diameter equals	Working stresses per square inch of section.		
	Long Leaf Yellow Pine.	White Pine, Norway Pine, Spruce.	Oak.
30	437	306	393
25	528	370	475
20	636	445	572
15	757	530	681
10	875	613	787
5	965	676	868

And in like direct proportion for intermediate ratios.

Columns and compression members shall not be used having an unsupported length of greater ratios than given in the tables.

No cast-iron column shall have a less diameter than 6 inches or less thickness than ¾ of an inch, and no part of a steel or wrought-iron column shall be less than ⅜ of an inch thick.

When a column is eccentrically loaded, and the difference between the moments—that is to say, "the load multiplied by its distance from the center of gravity of the section" on any two opposite sides—exceeds 25 per cent. of the smaller moment, then the sectional area of the column shall be increased so that a resisting moment is added which, if computed with the working stress for bending given in section of this act, shall be equal to or greater than the total difference between the moments.

The eccentric load of a column shall be considered to be distributed equally over the entire area of that column at the next point below, at which the column is securely braced laterally in the direction of the eccentricity.

All structures must be designed to resist a horizontal wind-pressure of 30 pounds for every square foot of surface from the ground to the top of same, including the roof,

in any direction. If the moments of wind-pressure exceed 75 per cent. of the moment of stability of the structure, the excess of such pressure must be resisted by bracing, and, in computing the dimensions of this bracing to resist such pressures, all the working stresses specified in section of this act may be doubled. If any building is not over 75 feet in height, the wind strains may be ignored.

In material subject to direct compression or tension the stresses per square inch shall in no case exceed those given in section of this act.

The shearing force per square inch shall in no case exceed the working stress given in section of this act.

In calculating the shearing stresses in metal of rolled sections, the web shall be considered to be the full depth of the metal, and the web alone is to be considered to resist the shearing forces.

In built sections the actual or net area of the web-plate shall alone be considered, and all holes for rivets and otherwise adding ⅛ of an inch to the diameter of the rivets or holes shall be deducted from the area of the section.

In all material under transverse loading the resisting moments computed with the working stresses given in section of this act shall be equal to or greater than the bending moments.

The deflection of beams or girders shall not exceed 3-100 of an inch to the foot of span under the total load.

In masonry arches the line of pressure shall be determined, and the stress at the intrados and extrados at no point shall exceed the working stress for the material as given in section of this act. Nor shall the dimensions at any joint be such as to permit the center of pressure to move more than ¼ of the width of the joint from its center.

Abutments must be proportioned so as to have not less than twice the moment of stability that is required to resist the thrust of the arch. Tie-rods shall be used where necessary to secure stability.

Retaining walls must be proportioned so as to have not less than twice the amount of stability that is required to resist the moment of overturning due to the pressure of the material behind the wall, together with its super-imposed load.

Strength of Materials.—In calculating the resistance of materials under strain (except in the case of columns) the following working stresses per square inch of sectional area shall be employed,—*viz.*,

NO. 1.—WORKING STRESSES IN POUNDS PER SQUARE INCH OF AREA OF CROSS-SECTION FOR DIRECT COMPRESSION.

METALS.		TIMBER.		
			With Grain.	Across Grain.
Steel	13,000	Oak	900	500
Wrought Iron	10,000	Yellow pine	1000	400
Cast Iron	15,000	White pine and Spruce	700	200

CONCRETE.

Portland cement, 1; sand, 2; stone, 4	250
" " 1; " 3; " 5	200
Rosendale cement, 1; " 2; " 5	140

BRICK-WORK.

Mortar—Portland cement, 1; sand, 3	250
Rosendale " 1; " 2	200
Lime, 1; sand, 2 or 3	125

NO. 2.—WORKING STRESSES PER SQUARE INCH FOR DIRECT TENSION. ROLLED SECTIONS, RIVETED WORK AND EYE BARS.

Steel	15,000	Yellow Pine	1,250
Iron	12,000	White Pine and Spruce	750
Cast Iron	3,000	Oak	1,000

NO. 3.—WORKING STRESSES PER SQUARE INCH FOR SHEAR.

	Iron.	Steel.
Web-plates	9,000	7,000
Shop rivets and pins	9,000	7,000
Field rivets and bolts	7,000	6,000
	With fiber.	Across fiber.
Yellow pine	150	500
White pine	100	300
Spruce & North Carolina pine	100	300
Oak	200	600

NO. 4.—WORKING STRESSES PER SQUARE INCH FOR BENDING.

Steel	16,000	Greenwich stone	50
Iron	12,000	Indiana limestone	135
Cast iron	3,000	Common limestone	75
Yellow pine	1,200	Sandstone	30
White pine and Spruce	800	North River bluestone	200
Oak	1,000	Concrete, Portland	40
Granite	150	" Rosendale	20

NO. 5.—MODULUS OF ELASTICITY, PER SQUARE INCH.

Steel	29,000,000	Yellow pine	1,500,000
Wrought iron	28,000,000	White pine and Oak	1,000,000
Cast iron	12,000,000	Spruce	1,200,000

THE CURE FOR CORROSION AND SCALE FROM BOILER WATERS.

By Albert A. Cary.

IV.

IN the preceding article, the extremely injurious effects produced in the boiler by oil scale were fully exhibited, and reference was made to the two general methods of treatment—skimming and filtration. We may now conclude by examining various devices actually employed in these processes, beginning with the simpler forms which merely adapt apparatus already installed so as to make it perform this additional function. Thus some hot wells are constructed so as to form large skimming tanks, and a considerable percentage of the oil is floated off.

One of these, from which very good results were claimed, is shown on the next page. It consists of a large rectangular tank, in which the water-level is kept constant by make-up water, if needed. The oily water enters at one side, and, after separation by gravity, is drawn off purified from below the surface on the other side, the separated oil overflowing from the top and the heavier sediment settling to the bottom. Make-up water was delivered into the right-hand chamber through a ball cock, the floating ball being set so as to keep a slight continual overflow of water when the plant was in operation.

Although this has given very good satisfaction, the owner states that it requires frequent cleaning, and a deposit of sticky oil is found to adhere to the entire surface.

Almost every conceivable adaptation of filtration has been tried for the removal of oil, both from the exhaust steam and from the water resulting from its condensation. For successful filtration two things are most essential—*viz.*, a slow passage of the fluid through the filtering material and frequent cleaning of this medium. These conditions are most difficult to obtain in practice, and many of the failures are largely due to the lack of these essentials.

Water from the hot well or the returns of heating mains is often led through sand as a filtering medium, the closed or pressure type of filter being usually used for this purpose, although large open filters are also sometimes found. The first water that passes through this bed of sand frequently carries oil with it, but, as some oil is retained in the sand, the free passage of the water is more obstructed, and good results are obtained. Finally, the deposit becomes so thick that the water

flows through with great difficulty, and the filter-bed must be cleaned. In some forms of filter cleansing is effected by reversing the current. The strong reversed current causes the bed to turn over and over, and the particles of sand are freed from their clinging deposit.

The oil thus separated passes up to the top of the filter, where it escapes through vent cocks, and the action is thus continued until the escaping water runs clear. During this operation of cleaning the supply of condensed water is either shut off, or sent on to the boiler through a by-pass, although in some plants a second filter is in operation while the first is being cleaned.

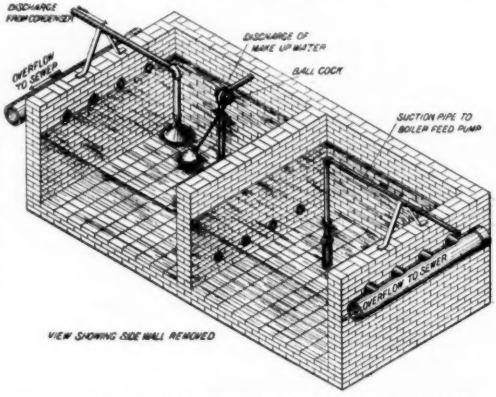


FIG. 1. HOT-WELL ARRANGED AS AN OIL-SKIMMING TANK.

Almost every conceivable filtering material has been used to remove oil. In marine practice, the water from the condenser is sometimes passed through long iron boxes tightly packed with sponges, two being generally used alternately, as they require very frequent cleaning to retain their efficiency. The dimensions given for this filter, for a 2,000-horse-power engine are, for each of the two boxes, 18 in. in height, 2 ft. in width, and 12 ft. in length, with open tops. The water passes through them longitudinally. Many steamers on Long Island sound use hay, straw, or excelsior for a filtering medium to remove the oil, with very good results, but small particles of these materials sometimes accompany the water as it leaves the filter, and cause trouble by getting on the seats of valves or by clogging passages.

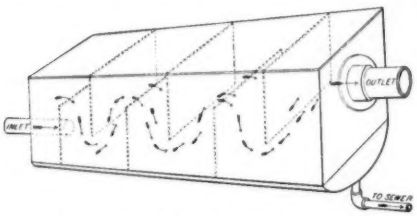


FIG. 2. COKE-FILLED STEAM WASHER.

Filter cloths, felt, common bagging, carpeting, and even blankets

have been used to get rid of this most troublesome impurity. The filters so far discussed handle the water, but the steam itself may be filtered. A very ingenious arrangement for this purpose, devised by an old marine engineer, consists of a rectangular box built of 2-in. cypress planks. It is 4 ft. wide, 6 ft. deep, and 10 ft. long. A number of baffles are slid into grooves so as to make the steam pass under one and over the next as it travels the length of the box. The exhaust steam-pipe enters one end, and passes to the condenser out of the other. This box is filled with ordinary coke. The bottom is perforated with many holes, which allow the arrested water and oil to drop into the inclined trough fastened below the bottom, whence they are discharged. When the coke becomes too foul for use, the baffle plates are drawn out of the box, and the coke is shoveled out and fired under the boiler, new coke being put in the box to replace the old.

Another method for the removal of oil from the steam is based upon intercepting the minute globules as they pass through a certain space. In one apparatus used, the exhaust is conducted into a large vertical cylindrical tank, entering it on one side and leaving from the other, the passage being obstructed by a number of inclined angle-irons, arranged in a staggered position and with their open sides facing the entering steam.

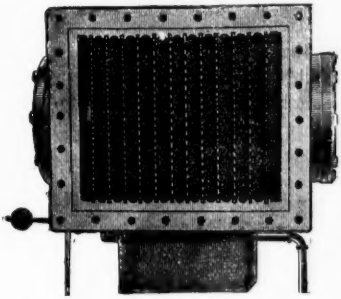


FIG. 3. INTERCEPTING OIL-SEPARATOR.

The intercepted particles of oil and water travel down the length of these angle-irons, and fall into a receptacle at the bottom of the cylinder, from which they are drained into the sewer.

A more compact form of intercepting apparatus employs a series of vertical screens, made of fairly heavy wire cloth flattened under considerable pressure, which are slid into top and bottom grooves. The mesh of these screens is varied to suit the service, but in no case is the combined area of openings allowed to be less than twice the area of the pipe. A very desirable arrangement is obtained when the screen nearest to the entering steam is of a small mesh, which breaks up and subdivides the current of steam very thoroughly, the next being of considerably larger mesh, and each successive screen towards the point of exit showing a further diminution in size of openings. The intercepted globules of oil and water pass into the receiver below, and

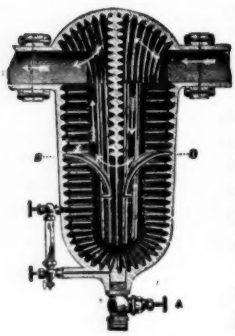


FIG. 4. BAFFLE-PLATE OIL-SEPARATOR.

thence are discharged. From time to time the screens are removed and cleaned. Figure 4 illustrates another form of apparatus, which is placed in a horizontal exhaust pipe, the arrows indicating the course traveled by the steam. An interfering central diaphragm throws the steam back upon the corrugated surfaces lining the interior of the entire chamber, to which a large percentage of the oil and oily water adheres.

Mr. W. J. Baldwin has long been working toward the same end along entirely different lines, his method being to blow the exhaust steam upon an extended surface of water; to increase considerably the size of the exhaust passage at this point, so as to materially decrease the velocity of the traveling steam, and thus cause it to drop much of its entrained matter; and, thirdly, to change the direction of the current. An apparatus of this description is now in use in some of the office-buildings in New York, and in many cases is giving good satisfaction; the construction is apparent from the figure.

The impossibility of affording the large space required by this apparatus in many plants led Mr. Baldwin to devise the form shown in Figure 6, and further improvements have made it more efficient than the large tank just described. The apparatus is essentially similar to the simpler form, but adds a series of dams (E D), past which the oil film is blown by the entering steam, and behind which it gathers at C, leaving under the entering current a clean water-surface, which is much more efficient in entrapping the entrained oil.

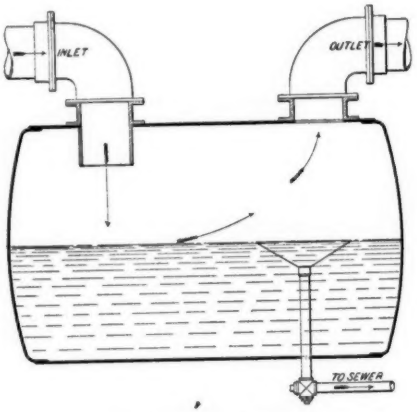


FIG 5. TANK OIL-SEPARATOR.

Another and still different apparatus for the removal of oil from steam is known as an oil-washer (Figure 7). This is a vertical cylin-

drical tank, containing a number of tubes. None of the tubes continued from one tube-sheet to the other. From the upper sheet a number of tubes drop to within about six inches of the bottom, while from the lower tube sheet an equal number point upward, measuring about fifteen inches long. These lower tubes determine the height of the water-level, and, of course, the upper tubes are immersed below this water-level some nine inches. The exhaust steam enters the chamber above, passes down the upper tubes, and escapes below the surface of the water. As it bubbles upward, the water washes out its oil and other impurities, and it passes out from the exhaust outlet located near the top of the chamber. Sufficient condensation takes place to keep up a continual overflow of water and oil, which pass down through the lower tubes into the drip-chamber below.

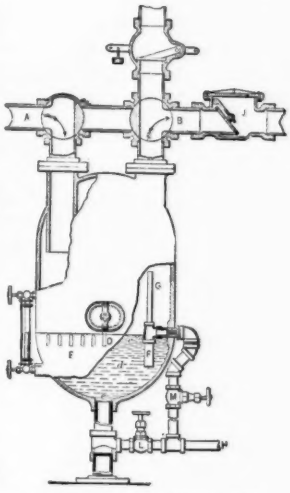


FIG. 6. BULB OIL-SEPARATOR.

In all apparatus requiring oily water to be drawn off through pipes, the greatest care must be observed to prevent these pipes from being stopped by the deposits of oil, which are sure to form within them. The pipes used should be some three or four times the diameter that would ordinarily be chosen, and at every turn and bend tees should be placed where elbows would ordinarily be used, and crosses should be substituted for tees. The unused ends of these fittings should be closed by brass plugs, which can be removed easily for inspection and for cleaning out the pipe; and every other possible provision should be made to facilitate such work.

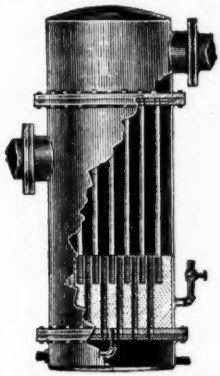


FIG. 7. STEAM WASHER.

The question is often asked: how much does a deposit of scale in boilers interfere with the transmission of heat to the water? the object being to determine the additional amount of fuel required when such a deposit has formed.

After a careful search in all directions, I

am still unable to find a satisfactory answer to this question. A number of experiments have been made to gain information on this subject, but, judging from the reports, either they have been conducted carelessly, or certain most important information has been overlooked or omitted. It may be discouraging at the outset to learn that this whole subject of heat-transmission through intervening substances is but imperfectly understood, even in its simplest form, such as the transmissionthrough clean plates. Authorities do not agree as to whether the rate of transfer of heat through the heating surfaces of boilers varies directly, or as the square of the difference in temperature of the heated gases and the water; some even hint at far more complicated laws.

That a difference does exist in the rate of transmission as the temperatures on the two sides of the intervening substance change is beyond all doubt. It changes also with the thickness of the intervening material, but much depends upon the nature of this material and its condition; for instance, glass will transfer heat much more readily than will the fine sand into which we can crush it. Owing to lack of positive information on this subject, some of the wildest statements have been made regarding the transmission of heat through scale of different thicknesses. One table has gone the rounds, and has been quoted again and again by some of the best authorities, in which is stated that scale $\frac{1}{16}$ of an inch thick will increase the quantity of fuel required 15 per cent.; $\frac{1}{4}$ of an inch, 60 per cent.; and $\frac{1}{2}$ an inch, 150 per cent.

This table is supposed to have originated with Prof. J. G. Rogers, of Madison, Indiana. It is barely possible that he may have obtained the first two figures by experiment with a certain kind of boiler scale, but such figures are very seldom obtained in boiler practice; in fact, I have found scale in boilers one inch thick, where no great difference has been noticed in the amount of fuel used. This scale was merely a light and very porous carbonate of lime, through which water and steam had very little difficulty in passing. The reader must not think, in consequence of what has just been said, that all scale deposits affect fuel-economy so lightly; my object in citing extreme cases is merely to show that there is a very wide difference in the effect produced in boilers with different kinds of scale, and that no one table can possibly express what this effect is with all kinds of scale.

Probably the earliest experiments on record for determining the effect of scale in boilers were made by John Graham between 1850 and 1860. These are described in "The Memoirs of the Literary and Philosophical Society" of Manchester, England (1860). In this paper Mr. Graham states that "a scale of sulphate of lime $\frac{1}{16}$ of an inch thick reduced the efficiency 14.7 per cent."

Experiments were conducted at Sibley College, under the direction of Prof. R. C. Carpenter, every precaution being taken to secure accurate results. The object of these experiments was to determine the heat transmitted in thermal units for each square foot per hour and per degree of difference of temperature. The apparatus used was a square box, in which a cast- or wrought-iron plate could be tightly fitted half way between the top and bottom, so as to form two separate chambers. The upper chamber held water, while steam was admitted to the lower. Thermometers inserted in these chambers showed their respective temperatures. The following results were obtained:

1 Difference of temperature of the two sides of the plate Deg. Fahr.	2 Clean wrought iron, $\frac{1}{4}$ inch thick.	3 Clean cast iron, $\frac{7}{8}$ inch thick.	4 Wrought iron plate and scale 1⅛ inch thick.	5 Cast iron plate and scale $1\frac{3}{4}$ inch thick.
25	28.8	21	2.7	1.8
50	60.0	48	5.5	3.6
75	96.0	84	8.2	5.4
100	150.0	127	11.0	7.3
125	228.	185	13.7	9.1
150	348.	255	16.5	10.9
175			19.2	12.7
300			22.0	14.6
400			33.0	21.9
500			44.0	36.2

The figures given in columns 2, 3, 4 and 5 show thermal units transmitted per square foot, per hour, and per degree of difference of temperature. The scale used in these experiments, unfortunately, was not analyzed. It was taken out of one of the boilers of Cornell University, and was very neatly fitted in the box, on top of the iron plates, so that the heat was obliged to pass through both.

Prof. Carpenter, in speaking of these experiments in his work on "Heating and Ventilation," says: "The results of these experiments show that the amount of heat transmitted does not depend so much upon the kind of metal as upon the media in contact with the metal on both sides." He follows the results of his experiments given above with other figures showing results obtained when, instead of steam and water, oil and water and air and water are used. The results being different, it is fair to infer that, had a flame been brought in contact with the lower surface of the plate (instead of steam), still different results would have been obtained.

Without a doubt no other scale produces so disastrous results as those produced by an oil or grease scale.

M. Hirsch experimented considerably to determine the effect of this scale, concerning which he states that the difference in tempera-

ture between internal and external surfaces is 90 degrees above that of the clean plate for an evaporative rate of 32 pounds per square foot per hour, and more than 360 degrees for an evaporative rate of 51 pounds, the latter degree of overheat being dangerous. In other experiments, even at moderate evaporative rates, not exceeding 35 pounds, the temperature of the external surface of the plate was 856 degrees,—greater than the melting-point of zinc.

Mr. A. J. Durston, engineer-in-chief in the British navy, conducted a series of experiments in 1892 to ascertain the loss of efficiency in the heating-surface of tubes in a boiler, due to a thin coating of grease deposit. For this purpose he had a tube taken out of a new ship and cut in lengths, each of which was tested by surrounding it with water (in an iron box), and applying heat inside of the tube by means of gas-jets. These experiments showed that the thin coating of grease deposited on these tubes during the ship's trial caused a loss of efficiency, as heating-surface, as compared with a perfectly clean tube, of from 8 to 15 per cent., the mean of many experiments giving 11 per cent. In another series of experiments Mr. Durston used a flat circular iron plate with the edges flanged, so as to form a circular dish 24 inches in diameter, 2½ inches deep, and ¼ inch thick. A constant water-level was maintained. This vessel was placed over a forge fire. With a moderate blast the temperature of the hot side of the plate was found to be 240 degrees, when fresh water was being boiled.

These temperatures were determined by the melting of various alloys of different metals, attached to the bottom of the vessel.

When more blast was applied, the temperature of the plate increased to 280 degrees. This was with a clean plate and with clean fresh water, when the temperature of the fire was 2,200 degrees. When this experiment was repeated after coating the bottom (inside) of the vessel with a greasy deposit 1-16 inch thick, the temperature on the hot side of the plate was found to be more than 550 degrees with a fire temperature of 2,500 degrees.

We now come to a most interesting branch of the subject,—namely, the treatment of scaling impurities, either by removing them entirely, or else by changing their character in such a way that they become much less troublesome.

Owing to the unfortunate fact that boiler-users have been, as a general thing, too busy to give this important matter of scale and corrosion a proper amount of study, they have become the victims of more impostors than exist in almost any other branch of trade. The boiler quack comes along with his remarkable boiler compound, fluid, or special apparatus, and, without the slightest knowledge of the character of the impurities held in the water used in your boiler, he offers

his panacea with a long list of letters of recommendation, written often by the heads of concerns who are far better acquainted with the financial end of their business than with the steam apparatus. These gentlemen generally depend upon what their engineers or other employees tell them. The writer knows of not a few cases where the unscrupulous venders of these compounds share some of their profits with the engineers, firemen, or other influential employees, which they can well afford to do, as the stuff they sell seldom costs them a quarter of what they get for it. These unscrupulous people, their methods, and their wares have been "shown up" from time to time in the technical papers, and they have not escaped the well-directed fire of the Hartford Steam Boiler Inspection and Insurance Company.*

They are often very tricky manipulators, able to give an apparent exhibition of the wonderful disincrusting power of their purges.

I caught one at one time cracking the scale out of a boiler by blowing it empty of its water under steam pressure, and then flooding it suddenly with cold water. Of course, this sudden contraction caused the scale to crack off and fall, but a boiler-maker was kept busy for some time afterwards in making the boiler tight. This is but one of the many tricks resorted to.

The best advice I can offer on this subject is: Never use any boiler compound, fluid, powder, or whatever else, unless you know positively just what it is composed of, and how it will affect the impurities in your boiler-water or the boiler itself. Many of these quacks pretend to have made a chemical analysis of the water to be treated. This is often a mere farce, as the same old compound is trotted out on all occasions. Some submit to their proposed victim what purports to be the analysis of the water. Many a time a subsequent *bona fide* analysis, made by competent chemists, has proved to me the absolute worthlessness of these first supposed analyses.

The reader must not understand that every boiler compound or powder on the market is a fraud; a few of them are highly beneficial when used with certain waters, which their makers frankly describe or specify. In the treatment of boiler-waters, always start with a careful analysis of the water, made by a competent chemist who has had experience in this line. Next, if you are thinking of using any chemical that has been offered for treatment of your boiler-water, let your chemist analyze it. If you are dealing with straightforward people, they will generally tell you the exact composition of their material, which your chemist can verify easily, after which he will be prepared to advise properly.

There are, besides these compounds, fluids, and powders, num-

* *The Locomotive.* See Vol. V, page 59, and Vol. XV, page 50.

berless mechanical devices offered for handling the impurities in the feed-water. Some of these are effective, while many others are worse than useless; expert advice should be obtained before adopting them at the risk of an accident more or less serious.

Impurities may be removed from boiler-waters by mechanical treatment or by chemical treatment. Under the former heading probably the best known method of getting rid of these impurities after they have been precipitated on the boiler is by use of the blow-off cocks. Considerable mention has been made in the preceding pages of this indispensable boiler adjunct, and the reader will remember that both the "surface blow" and the "under blow" have been referred to.

When suspended matter settles in boilers, it is generally deposited near the discharge-end of the feed-pipe, or else (more frequently) where the circulating currents are the weakest; thus, in the case of horizontal shell boilers, we find the largest deposit on the bottom at the rear end, and therefore the under blow-off pipe is usually attached at this point. By opening the blow-off cock at frequent intervals a great deal of this deposit can be gotten rid of while soft. Bottom blowing, as this is sometimes called, is frequently conducted with little regard for existing conditions. Those in charge of boilers using bad feed-water often blow off their boiler but once a day, or twice a week, or at some other long interval of time, regular or irregular. They seem to think that, after a long lapse of time, all they have to do is to open their blow-off cock, and keep it open until the water runs clear. But they succeed only in drawing out the soft matter precipitated in the immediate vicinity of the blow-off opening, while the deposit but a short distance away is left comparatively undisturbed. Blowing off several times a day (where the precipitation is sufficient to warrant it), and opening the cock but a few seconds each time, will produce far better results than blowing less frequently and longer, as this method will remove the precipitate as fast as it forms in any appreciable quantity and before it has a chance to form into a hard scale.

The discharge pipes from many blow-off cocks are connected into other piping or tanks in such manner that the discharge cannot be seen, and therefore the time for closing is purely a matter of guesswork; the result is either a foul boiler, from insufficient blowing, or else a waste of too much hot water, due to blowing too long. The usual method of proceeding in such cases is to blow off the boiler at stated intervals (depending upon the purity of the water), until the water-level in the boiler falls one or two gages. Subsequent inspection of the interior of the boiler will show whether sufficient time has been allowed; if no scale be formed, the quantity of water blown off

each time can be reduced, and the next internal inspection will determine whether the blowing-off has been regulated rightly.

When the deposits in the boiler are due to mere concentration of the solution, precipitation taking place when they become supersaturated, the quantity of water blown off should contain a quantity of salts equal to that contained in the introduced feed-water.

Numerous devices have been invented to increase the area affected when the blow-off cock is opened. By one arrangement the blow-off pipe projects up through the bottom of the boiler, and has a T-fitting screwed on its end. From each of the two openings a piece of pipe projects, one running towards the front of the boiler and one towards the rear; the ends of these pipes are closed, but they are perforated on their under sides, so that the dropping precipitate will not tend to close the openings. When the blow-off cock is opened, the mud-like material is drawn into all of these under openings, thus accomplishing the required result. In some boilers a catch-plate is arranged to receive all the falling deposit. This is placed an inch or two above the bottom sheet of the boiler, and blow-off connections are made to its upper surface.

When the blow-off pipe is connected directly to the bottom of the boiler shell, the area affected when the blow-off cock is opened is comparatively small. Many people seem to think that, when this discharge takes place, all the impurities on the bottom of the boiler must rush out, but this is not so. The only area cleared is included in a circle concentric to the pipe-opening, and is very limited in diameter. This is well illustrated in the case of a sink containing water laden with impurities. When these impurities settle and the stopper is pulled out, it is impossible to drain off the settling, especially if the water-level be kept constant.

Thus far very little has been said of "surface blowing," which is, in many cases, as essential as "bottom blowing." Many of the materials held in chemical solution when precipitated first appear as a scum on the surface of the water. Oil also floats, and so do some of the lighter materials held originally in mechanical suspension. By use of the "surface blow" we are able to skim from the surface of the water a large percentage of these

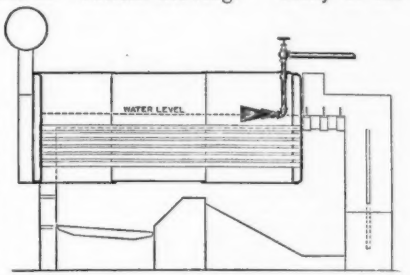


FIG. 8. SURFACE-BLOW-OFF, SHOWING COLLECTING-FUNNEL. SIDE VIEW.

materials before they have a chance to settle. The Hartford Steam Boiler Insurance Company show a very effective form of collecting-funnel in the *Locomotive*, which is reproduced in Figs. 8 and 9. This funnel, it will be seen, extends pretty nearly across the width of the boiler at the water line. When the valve is opened, the pressure in the boiler drives the water and steam up along the vertical pipe, and so on to the place of discharge, carrying with it all its floating impurities.

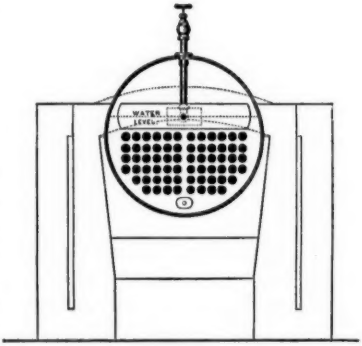


FIG. 9. END VIEW OF COLLECTING-FUNNEL FOR SURFACE-BLOW-OFF.

There are a number of automatic skimmer devices on the market, which are arranged so as to keep up a continuous circulation of water through a settling-chamber or a filter, where much of the impurities are retained, the clarified water being returned to the boiler.

A well-known form of one of these apparatus is shown in Fig. 10. The settling-chamber is placed above the boiler. When the valves H and H are opened, steam rises through both pipes (the valve F at first being open to allow escape of air) until it fills the chamber B. This steam condenses, and, because of the partial vacuum thus formed, water rises and finally fills the chamber. Then the circulation begins, the dirt-laden water rising along the pipe D, and, after passing through the chamber B, where much of this sediment drops to the bottom, continues its course back into the boiler through the pipe E. The valve F is occasionally opened, which discharges the dirt from the bottom of the chamber B.

Another automatic skimming device, shown in Fig. 11, furnishes a continuous passage from the scumming-funnel through the sediment trap back into the bottom of the boiler. The lower connecting pipe is placed in the path of the hot gases, and, as it becomes heated, the water that it contains rises, establishing a circulation which causes the water from the upper surface to flow into the funnel,

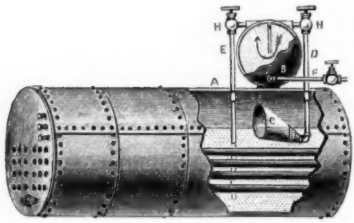


FIG. 10. AUTOMATIC CONTINUOUS SURFACE-BLOW-OFF.

carrying with it its floating sediment. The clarified water is collected from under the suspended bell shown, and returned to the boiler. Both of these apparatus have special arrangements for taking care of oil as it is drawn from the surface of the water, and it is claimed for both that they prevent foaming.

Probably no method of internal mechanical treatment is more widely known than the use of manual labor for the removal of scale after it has formed.

The character of the scale and its degree of hardness have a great deal to do with its treatment. Some scales are so soft that they may be easily swept out of the boiler or washed out by a stream of water, after they have been started away from the shell. Some are so hard that they actually resist the chisel more effectually than the metal itself, being either formed in close layers next to the shell or actually cemented to the metal of the boiler by corrosion or rusting.

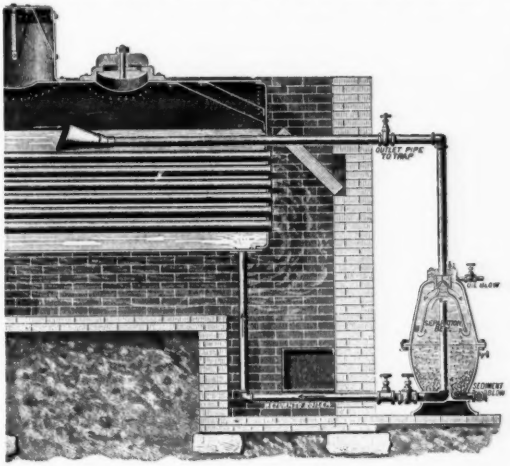


FIG. 11. AUTOMATIC CONTINUOUS SURFACE-BLOW-OFF.

These hard resisting scales have to be removed by vigorous chipping, the tools for this purpose varying from a common hand-chisel to a long rod with a chisel-like end, which is used like a battering-ram to reach inaccessible parts of the boiler.

Steel rods are sometimes bent on one end, like a shepherd's crook, the curve corresponding to the shape and size of the tubes. The operator takes a position on top of the bank of tubes, and reaches down between the spaces, hooking his tool around some scale-covered tube below, while a second man strikes the upper part of the bar so as to make it slide along, and thus scrape off the scale. In many boilers the best possible cleaning of this kind can be only an imperfect job. In water-tube boilers containing straight tubes cleaning can be most effectively done by means of scrapers and steel brushes, but,

where a long accumulation of scale has been allowed, a regular boring tool has sometimes been required to bore out the scale.

A great deal of damage can be done to a boiler by use of chipping-tools, as the surface of the metal is often chipped off along with the scale, laying open a spot for corrosion. I have also seen rivets and lap-joints badly battered with such tools, as well as braces, stays, and other boiler parts. There is no excuse for allowing a boiler to get into a condition so foul as to require this destructive treatment, and it will pay the owner many times over to consult an expert, who will soon be able to remove most of the cause of danger.

Another method of internal mechanical treatment introduces into the boiler certain substances which will coat the little precipitated crystals or floating particles of mud, etc., with envelopes which prevent them from coming in contact and adhering when they settle. Some of these form a mucilaginous mixture with the water. Slippery elm, starch, and potatoes are examples of this class. This kind of remedy cannot be considered desirable, as it frequently causes foaming, and any considerable deposit of this kind involves great danger from overheating of the plates. Another remedy of this kind, extensively used in this country, is petroleum, as well as kerosene oil. The petroleum oil has much more of this enveloping quality than the kerosene. Besides producing this effect on the unprecipitated scale matter, both have an active "rotting" effect on the scale already formed, the kerosene in this case being superior to the petroleum. Crude oil should never be used, positively nothing but carefully-refined oil, which has been deprived of its tar and wax, as these form a tough, impervious scale productive of bagging sheets and collapsed flues. Both petroleum and kerosene should be fed to the boiler with the feed-water, drop by drop, through a sight-feed apparatus, similar to those used to feed oil to the cylinders of engines.

Under no consideration should a large amount of oil be fed to a boiler at one time. The more volatile portion of the petroleum is distilled off quickly in the hot boiler, leaving the least efficient portion behind, while practically all of the kerosene is vaporized at once.

Where hard scale has formed in a boiler, it is sometimes most effectually treated by giving it a coat of petroleum. This may be applied with a brush, or squirted on. But an easier method of application is to first fill the boiler with water above the line where the oil is to be applied, run the oil in on the surface of this water, and then let the water gradually run out of the boiler, leaving the oil clinging to the interior surface. Kerosene is most effective in destroying the tenacity or coherence of this deposited scale, but it is dangerous to use, on account of the explosiveness of the vapor it gives off.

Great care must be taken, in using either the petroleum or kerosene in this way, to have no lights in the vicinity of the boiler, as men have been very seriously injured by lack of prudence in this work.

Another method of internal mechanical treatment is by use of interior scale-collectors, designed to fit inside of boilers, in the steam space, or just below the level of the water. Those placed in the steam space generally receive the feed-water in the form of a spray or a thin sheet, the object being to expose as large a surface as possible to the hot steam, thus causing the water to become heated quickly to a temperature that will precipitate the material held in chemical solution. This falling water is received sometimes in a funnel, in which the precipitated matter is supposed to fall to the bottom, while the clear water overflows to mingle with the water of the boiler. By occasionally opening a blow-off connected to the bottom of this funnel, the deposited matter is blown out.

In another arrangement the water enters one end of a long pan inclined in the steam space of the boiler. After coursing its way down the length of this pan, its course being constantly changed by a series of baffles, the water escapes from the lower end, and much of the precipitated scale-matter is supposed to remain in the pan in a position to be easily discharged through a blow-off pipe. Still another form of apparatus consists of a service of spill-pans, one placed above the other so that water enters the top pan and spills in a thin sheet, to the one below, the water thus continuing to the bottom. In apparatus of this kind, time, a most essential consideration, is not thought of. No precipitation can be perfect where a certain amount of time is not allowed. Another serious objection to the use of this form of apparatus is that the cold water is introduced into the steam space, thus abstracting its heat and producing wet steam.

The same objection may be raised to some of those apparatus located near, but just below, the surface of the water, as these devices, into which the cold water is being constantly introduced, form a refrigerating surface, which interferes with, and chills, the bubbles of ascending steam. One consists of a long pipe several times the diameter of the feed-pipes, placed at an inclination just below the surface of the water. The feed-pipe is run concentrically down this larger pipe, discharging near the lower end. As the feed-water is raised in temperature by the surrounding water, it is supposed to deposit much of its impurity in the larger pipe, from which provision is made to blow it out, by connecting a blow-off pipe to its lower end. In another arrangement of this kind a large pipe, four to six inches in diameter, is run, in a horizontal shell boiler, from one head to the other, passing through both heads, and having tapered brass plugs

screwed into the ends. The feed-pipe is run concentrically through the center of this large pipe, and has a series of slots one-fourth of an inch wide cut in it near the rear end of the boiler. The feed water escapes through these, and then has to pass back to the front end of the boiler along the larger pipe, where it escapes through slots, and mingles with the water in the boiler. From time to time, when the boiler is shut down, the plugs are taken out of the ends of the large pipe, and the internal feed-pipe is removed, allowing a thorough cleaning to be made. When the boiler is in operation, a blow-off pipe attached to the rear plug is opened from time to time to blow out the impurities.

A great trouble with many of these internal apparatus is that they are much in the way when the interior of the boiler is being cleaned or inspected, and often lead to bad work and to neglect. Another trouble is that they fill up with scale, etc., and thus become very ineffective, and sometimes even dangerous, and it is very questionable, with many of them, whether as good, if not better, results cannot be accomplished with properly-manipulated blow-offs.

We may next consider external mechanical treatment of the feed-water. Mention has already been made of settling the floating matter in big tanks or reservoirs, before using the water in the boiler. It will be seen later that water may be treated chemically in comparatively small tanks, with rapid precipitation and final settling of the impurities to the bottom.

On the principle that it will take the floating impurities in water but half the time to settle through a depth of six inches of water that it will take them to settle through twelve inches, settling towers have been devised containing a series of inclined shelves so arranged that a certain amount of water will fill one shelf and then spill over to the next one below, settling taking place on each of these shelves, from which the impure deposit can readily be run out. Probably one of the oldest of all known methods for removing floating impurities from water is the use of filters. These have been somewhat described under our treatment of oil in the water. Sand is probably more widely used than any other filtering medium, as it is less capable of becoming itself fouled, and its sharp edges, rubbing against each other when set in motion, have a very cleansing effect.

A perfectly clean sand filter-bed is seldom efficient to hold back the finer floating particles, but this bed soon collects a sufficient quantity of the larger particles, and, as these interfere with the freer flow of the water, they hold back the minute matter that formerly found its way through the bed. The efficiency of a filter depends upon the state of cleanliness in which it can be kept, and thus much depends upon ease of manipulation in accomplishing this purpose.

Filter presses are being most effectively used for removing the impurities from boiler feed-water, especially after this water has left a settling-tank. The filter press is constructed with a series of plates which have their outside frames carefully faced and fitted, so that the frames form water-tight joints where they come in contact one with the other, even under a considerable water-pressure. Filter cloths are placed between these plates, through which the water is forced by means of a pump. When it becomes necessary to clean the filter press, the plates are released by turning back the screw, and the dirty filter cloths are removed, new ones being substituted. The cloths can be washed over and over again, and thus the expense of manipulation is not great.

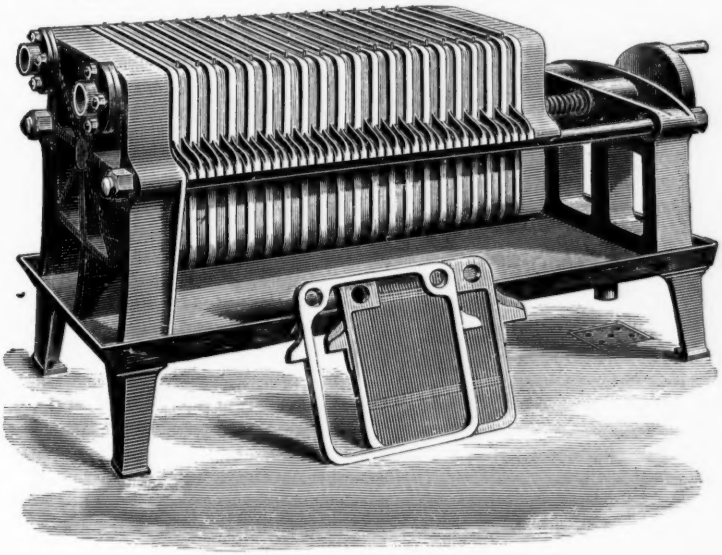


FIG. 12. A FILTER PRESS.

Heating the feed-water is a most important method of external mechanical treatment. Exhaust steam will cause a precipitation of most of the carbonates, but, when sulphates are present, the higher temperature of the steam from the boiler is required.

In one form of this apparatus, a cylinder placed horizontally contains a series of sheet-iron shelves arranged one above the other, so as to slide in from the end, which opens. These shelves are in the form of shallow U-shape pans. The feed-water is admitted into the top

pan, which soon becomes full and overflows into the pan below, and so the water continues until the bottom of the purifier shell is reached, when the water is conducted to the boiler. The live or exhaust steam, whichever is used, is admitted into one end of the shell, and finds an exit at the opposite upper end. The water is allowed to remain in these pans sufficiently long to precipitate the greater part of its impurities, and finally the pans, when filled and crusted, are taken out, cleaned, and returned to their places.

Another apparatus depending upon a similar principle for working is shown in Fig. 13. This is a vertical cylinder filled with corrugated iron shelves, upon which the deposit takes place in a way similar to that just described. The steam inlet is plainly shown, and just inside of the shell opposite this inlet is seen a herring-bone, ribbed plate, against which the exhaust steam is thrown with its contained oil. The oil is supposed to be retained by these ribs, and to finally drop to the space below. The steam then continues its passage among the corrugated shelves, and, after heating the water so as to cause a precipitation, escapes from the top of the cylinder. Another and a similar form of this apparatus is used with live steam. Claims are often made by the manufacturers of fuel-economizers and feed-water-heaters that their apparatus are water-purifiers. This is true only to a limited extent, varying according to the form of construction. The fuel-economizer is but a supplementary boiler, placed in the path of the waste gases, between the boiler and the chimney. The feed-water is made to pass slowly through the tubes, while the hot gases around them raise its temperature. This is the primary object.

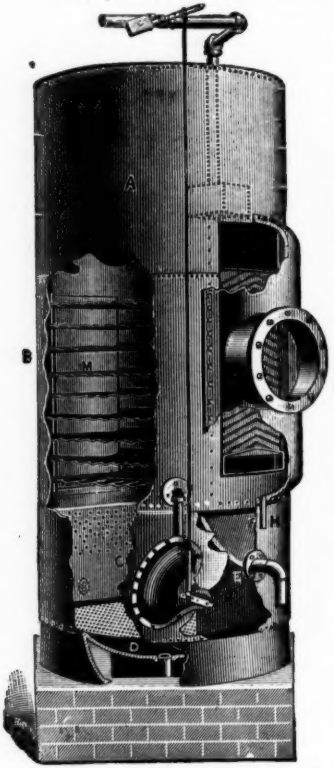


FIG. 13. EXHAUST-STEAM FEED-WATER PURIFIER.

Secondarily, the rise in temperature is generally sufficient to cause a precipitation of impurities from their chemical solutions, and a deposit in the tubes and headers.

With such a non-conducting deposit in the economizer tubes, of course the capacity of the apparatus for absorbing heat for its contained water is reduced. Hence, for the best working conditions, the water should really be purified before it is admitted to the economizer. Much the same comment can be made regarding most of the closed exhaust-steam feed-water-heaters, although there is seldom anything deposited in them that will form a hard scale. Crooked and bent tubes in these apparatus prevent the easy removal of the scale and the oil deposits. The open exhaust-steam feed-water-heaters receive the steam and water in the same chamber, where they are intermingled. The scale-making material is generally precipitated, in these apparatus, on shelves, in pans, or in some filtering material through which the water passes, and facilities, more or less perfect, are provided for cleaning these receptacles. Open heaters are, unfortunately, charged, from time to time, with introducing oil into boilers, this oil, of course, coming from the exhaust steam, which is condensed in the heater.

Turning now our attention to chemical treatment, we find that the most widely-known practice of this kind consists in feeding chemicals directly into the boiler, where they act upon the scale-making impurities. This, although very simple in manipulation, cannot be endorsed as good engineering practice. The boiler has all that it can do to discharge its primary function,—namely, to make steam,—without being used as a chemical laboratory and precipitating tank.

The principal object of this method of treatment is to change the character of the precipitated matter so that it will form a soft, instead of a hard, scale, which can be more easily removed from the boiler. Some chemicals also soften or "rot" old scale formations.

Some chemicals are introduced into boilers to neutralize acid waters, and these three results are practically all that are attained by this method of treatment. Is it a step in the right direction to put more solid matter into a boiler than is originally contained in the feed-water? Is it not far more rational to remove this scale-matter from the water before introducing it into the boiler? We have already seen that this can be, in great measure, accomplished. The expense of equipping a plant with these more refined methods, or the lack of room in which to place the apparatus, sometimes forces the adoption of the cruder method of treating the water in the boiler with chemicals. The more refined methods are used far more abroad than in America, and I believe that, before many years, we shall wake up to the fact that an investment in a good purifying plant for boiler-waters will be as good an investment as can be made on the steam plant. With impurities constantly entering the boiler, its efficiency begins to decrease from the day that it is started.

Why not keep the boiler up to its original efficiency and ability to "steam easy," and save coal by keeping the boiler continuously clean?

The boiler quack is at his best when selling his mixtures for treating the water inside of the boiler. I have already named the principal chemicals used for this purpose. All are very cheap. Tannic acid, in one form or another, is often used, but an excess of this is dangerous in a boiler.

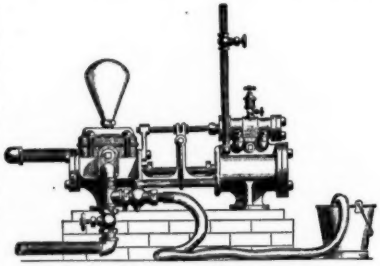


FIG. 14. PUMP CONNECTIONS FOR FEEDING SOLUTIONS TO THE BOILER.

Solids (powders, etc.), should never be introduced directly into a boiler. They should always be dissolved entirely, and the solution only should be used. I have found solids of this kind deposited in masses, and in most dangerous positions.

Three most effective methods of introducing solutions into boilers are illustrated * in Figs. 14, 15, and 16. In Fig. 14 it will be seen that the solvent is put into the pail or tub, from which it passes through the suction-hose and plug-cock into the main suction-pipe of the pump. In Fig. 15 the suction-tank is placed over the pump, and, when the valve below the receptacle is opened, the solution passes into the pump. Fig. 16 shows an arrangement by which an injector can be made to pick up the solution and feed it to the boiler.

FIG. 15. PUMP CONNECTIONS FOR FEEDING SOLUTIONS TO THE BOILER.

The fundamental process for treating water chemically outside of the boiler is the Clark process, described in the second article of this series. For this process, two or more tanks are used, each of which will hold at least six or eight hours' water-supply.

The "raw" water is first treated in one tank. After it has been thoroughly mixed with the chemicals a precipitation takes place, the scale-making material falling to the bottom of the tank. This settling requires from six to ten hours, and then the upper water in the tank is ready for use in the boiler. While this is being used, water is being similarly treated in the adjoin-

* Reproduced from *The Locomotive*, published by the Hartford Steam Boiler Inspection and Insurance Company.

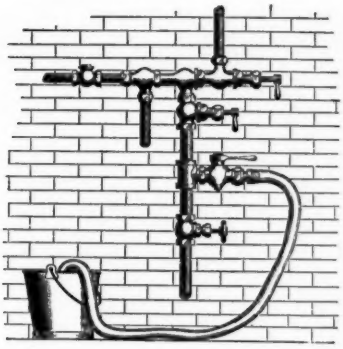


FIG. 16. INJECTOR CONNECTIONS FOR FEEDING SOLUTIONS TO THE BOILER.

ing tank, and thus this process is continued. The "mud," or precipitated matter, is easily removed, from time to time, from the bottom of the tank, by brushing or washing out with a hose.

A Cincinnati concern, manufacturing one form of apparatus for this process, places a special stirring device in the bottom of the tanks, similar to a propeller with a number of blades.

The "raw" water and the solution are thoroughly mixed by turning this mixer, and, besides, the previously-deposited precipitate is stirred up and mixed with the water. This has proved a valuable process, as the old precipitate settles much more quickly than the new, and drags the new down with it.

After the settling, a pipe is arranged so as to draw the water from near the surface only, while the precipitation is being completed beneath. This pipe is hinged near the bottom of the tank, while the free end has a float attached, which rises and falls with the variation of the water level. After this settling, a little sediment is still found in the water, but this is removed by passing the water through a filter before sending it into the boiler.

Enough has been said to show the reader that scaling and corrosion in boilers are not necessary evils, and, further, that the treatment of boiler feed-water is a purely engineering and chemical problem, capable of being handled in a thoroughly scientific and practical manner, without guesswork or the use of the rule of thumb.

In the selection of boilers, many have considered the quality of the feed-water one of the governing factors, and have, in consequence, advised, where bad feed-water is obtained, the use of boilers known to be the least economical of all that can be found in the market.

Surely this is not in accordance with the progressive ideas of to-day.

The best and most economical boiler that the market can afford is none too good for any steam plant. If the feed-water proves bad, let it be treated properly. In this way only can a steam plant compete with its neighbors successfully.

REVIEW OF THE ENGINEERING PRESS

The Floods of 1897.

THE damage done by the floods along the Mississippi river, notwithstanding the immense sums that have been expended to keep this wayward stream within bounds, has reopened discussion upon the great engineering problem of restraining it and similar streams from overflow, even when carrying in their channels extreme volumes of water. The discussion has been general, not only in the technical engineering press, but in publications devoted to miscellaneous literature (*Harper's Weekly*, April 17) and to finance (*Bradstreet's*, April 17). *Bradstreet's* advocates the reinforcement of the Mississippi banks under national direction, and shows some of the disabilities attending the levee system. It quotes from a southern newspaper to show that "the flood of a single season is capable of creating loss and damage, in some half dozen States, of hundreds of millions of dollars. This is too much for a great continental river carrying the waters of half the union to be permitted to inflict, at a single blow, on the people of the southern lowlands." It also quotes a correspondent of the *St. Louis Globe-Democrat* as voicing the general belief in the inefficiency of the present levee system. The correspondent referred to, after a trip through the valley from Cairo to Vicksburg, says that "the consensus of opinion of the steamboat men, planters, and residents of cities is that 'the levees must go.'" He adds that the exceptions to this view he finds among government engineers and the members of the levee boards. "Even they," he says, "admit that the levee system has proved a failure this year, so far as giving protection to the lands behind them is concerned, and the only defence they can offer is that the high water of 1897 is without precedent, so that no calculations based on the conditions of previous years could be taken into account in coping with the floods. The attempt to confine the river within narrow banks by means of levees, where successfully done, might be defended at least on the ground of its success. When, however, this plan is tried, as it was this year, and fails, and the immense power of the water for evil is accentuated by every attempt to confine it, then the evils of the levee system are brought more directly in evidence." Speaking of the belief by the planters in private levees about the few acres included in their orchards, gardens, and plots of ground surrounding their homes and the homes of their employees, he says that the value of the overflows in fertilizing the lands is acknowledged, and that the prehistoric mounds along both sides of the river have probably been utilized in effecting this purpose. He intimates that this may have been a use for these mounds hitherto unsuspected by antiquarians. In the article upon this subject, *Bradstreet's* evidently favors national supervision of this river. *Harper's Weekly*, in a very interesting article describing the floods at various points along the river, and their effects, says that, "notwithstanding the tremendous damage done by the present flood, it will probably be found that the element of safety along the Mississippi river system has been increased of late. In the flood of 1882 the total number of crevasses was 284, aggregating 56.09 miles in width; in 1883 the crevasses numbered 224, with an aggregate width of 34.1; in 1884 the crevasses numbered 204, aggregating 10.64 miles in width; in 1890 the crevasses numbered only 23, aggregating about 4.25 miles in width; in 1892 and 1893 the percentage of breaks is said to have been less than in 1890. In the flood of this year the serious breaks thus far do not number more than eight or ten, the chief of which—that at Flour Lake, Mississippi—has caused so much devastation in the Yazoo Delta." Further light is thrown upon the disabilities of the present system of constructing levees under State supervision by a further statement in *Harper's Weekly*, referring to the work of the

Mississippi river commission, which has been in existence since 1879, and has spent large sums of money on improvements. "It was found that in many of the levees constructed by the States corruption had been potential, and that, as a result, the levees would give way in time of a great flood. There was also no harmony between the various States as to the system of constructing levees. Arkansas, for example, was found to be indifferent to Louisiana's welfare. It became necessary for Louisiana to go into Arkansas territory, by permission of that State, and to locate levees for the protection of Louisiana. The latter State, of course, could not police these levees in Arkansas. All of this showed the need of intelligent coöperation between the States in the proper development of the great river's resources, and the protection of the vast commerce that lies along its great length. It will be read with surprise that there are several hundred miles along the river without immediate levee protection." One of the important engineering facts developed by the study of the problems presented to the river commission is that the opinion formerly held that the elevation of the levees was followed by the elevation of the river's bed is erroneous. The exact reverse is the case. With high, firm levees, the river scours itself out and deepens its channels in times of flood.

Impure Water and Disease.

A DOUBLE number (March and April) of the *Albany Medical Annals* deals almost wholly with a discussion organized by Dr. Henry Hun, at the request of the president of the Medical Society of the State of New York, and held at the meeting of that society in January of the present year. The papers which make up this able discussion represent the most advanced views of physicians, chemists, and bacteriologists on the relation of impure water to disease, and the cure and prevention of such diseases as are disseminated by contaminated water. The breadth of the discussion is indicated by the titles, and the names of the authors, of the papers: "Common Causes of the Contamination of Drinking Water," by Timothy Matlack Cheesman, M.D.; "Diseases which can be Directly Traced to Contaminated Drinking Water," by George Blumer, M.D.; "A Statistical Inquiry into the Relation between Contaminated Drinking Water and Typhoid Fever," by John S. Billings, M.D.; "Danger of the Domestic Use, Other than Drinking, of Contaminated Water," by Rowland Godfrey Freeman, M.D.; "Water Purification," by Thomas B. Carpenter, M.D.; "Methods of Preventing the Pollution of Water," by Edward K. Dunham, M.D.; "Life History of the Typhoid Fever Germ Outside the Body," by F. C. Curtis, M.D.; "Bacterial and Allied Tests as Applied to the Clinical Diagnosis of Typhoid Fever," by John Slade Ely, M.D.; "Typhoid Fever in Infancy," by W. P. Northrup, M. D.; "Medicinal and Dietetic Treatment of Typhoid Fever," by William S. Ely, M.D.; "The External and Internal Use of Water in Typhoid Fever," by Charles G. Stockton, M.D.; "Disinfection of Typhoid Excreta," by Gilman Thompson, M.D.; "Discussion on Papers on the Pollution of Water," by Prof. William T. Sedgwick. It will be seen that the general subject is well covered by the papers on the special topics, and that many of these papers, particularly those on the purification of water, causes of contamination, methods of preventing pollution, and statistics, have a direct bearing upon the practice of municipal engineering, in which water-supply ranks next to drainage in importance. In short, we should think that this collection of papers ought to find a place in the library of any municipal engineer who wishes to bring his works of reference as nearly up to date as possible. Of course, it is impossible in a collective notice of so many papers to indicate the nature of each by reference to general or special features. We will, however, make one or two quotations that will justify the opinion we have expressed of the value of the collection. In Dr. Carpenter's paper we find the following conclusions:

"(1) Purification of water should be municipal, not domestic, because domestic filtration cannot be relied upon. (2) Domestic purification can be best obtained

by heating to 80° C., for twenty minutes. (3) All evidence available at the present time favors the superiority of 'natural' filtration for purification on a large scale. (4) With few exceptions all American cities furnish their inhabitants with water that is at least suspicious, and in most cases polluted. (5) A continued typhoid mortality of over 20 per 100,000 means a polluted water and a preventable sacrifice of human life." These conclusions are all sustained by facts, arguments, and statistics presented in the body of Dr. Carpenter's paper. Dr. John Slade Ely's paper on "Bacterial and Allied Tests" shows that, to positively prove or disprove the presence of the typhoid bacillus, the water must be subjected to the following tests (quoted from Loesener), which sum up an exhaustive examination of the literature of the subject.

"(1) The appearance of the superficial colonies in gelatine plates. (2) The very active motility. (3) The number of flagella originating from all parts of the bacilli. (4) Decoloration by Gram's method of staining. (5) Growth on media containing grape, milk, and cane sugar, without gas formation. (6) Growth in milk without causing its coagulation. (7) Growth in proteid—containing media, without generating indol. (8) Production of acid when grown in whey, but not in excess of three per cent. as tested by one-tenth normal soda solution. (9) The growth on potato. (10) The failure to grow in Maassen's normal solution with glycerin." Many other tests are named and described. A valuable feature of this paper is a bibliography of the subject.

Dr. Cheesman, in his paper, asserts that all waters obtained from the neighborhood of populous districts are to be regarded with suspicion. He also states the conditions most favorable to the multiplication of pathogenic bacteria,—to wit, a fluid abundantly charged with organic matter, protection from light, and favorable conditions of temperature. Unfortunately these are the very conditions to be found in many of the tanks used for storing temporarily the water-supply of dwellings. "Many of them may not have been cleaned out for years; others may have been more or less thoroughly cleaned once a year, and then, perhaps, under protest, by order of the health authorities. Such tanks are often built so that it is impossible to get at them to clean them at all. The presence of a single pathogenic micro-organism in such a cistern might result in its active multiplication and in a serious outbreak of disease."

Dr. George Blumer held that, if the cause of a disease can be isolated from the water, and if the great majority of the individuals attacked by the disease partook of the water, and if there is no other source of infection common to all the individuals attacked, this proves with certainty that the disease is caused by drinking water. Dr. Blumer is director of the Bender Hygienic Laboratory at Albany, a position which gives an authoritative character to what he says or writes upon the relation of impure water to disease; yet, as in the three proofs he names one is negative, we must disagree with him that they together establish a certainty. To establish a negative proof is a task from which the ablest logicians will shrink. We may prove that *C* exists as a factor, and that *D* in some form always accompanies *C*, but to show that some other unknown factor, the nature of which even is a mere matter of conjecture, does not also exist is indeed a task. We should be willing to admit that the three conditions named by Dr. Blumer establish a very strong probability, even a convincing probability, warranting belief and action, but we should not class such a probability among absolute certainties.

The Center-Court Apartment-House.

OUR much-esteemed cotemporary, *The Engineering Record*, has been referred to in these pages several times as a pioneer in the movement for improved apartment-houses for working-people of small incomes; it has consistently maintained its support of this movement for many years. Under the above title it presents (April 3) an illustrated description of a center-court apartment-house, which, it is presumed, was thought worthy of the two pages of space

devoted to it. We are ready to admit that the design has some commendable features, but the pitiful meagerness of the room provided for each family impresses us very unfavorably. We are told that this building has been erected on West Twenty-eighth street, New York; that its purpose is for rental in low-priced apartments and ground-floor stores; that it is a semi-fire-proof structure; and that it was "designed with especial regard to the best utilization of space on an ordinary city site, the most convenient arrangement of rooms, and to secure the greatest amount of light and ventilation possible under the conditions." We are further told that the ground on which this structure stands is a fifty-by-one-hundred foot lot, and that the building is a five-story and basement apartment-house. Within this space are to be housed twenty-two families and three ground-floor stores. There is a court about nineteen feet square in the center of the building, which is open on the south, permitting free access of air, and, it is claimed, of sunlight to the very bottom; but as the opening from the ten-feet-wide yard at the rear into this court is only about three feet in width, it seems that direct sunlight can reach the bottom of the court for only a small part of each day, and that this claim is more fanciful than real. "The staircase halls are all lighted from top to bottom by windows on each floor, and have, in addition, ventilating skylights at the roof. To insure protection from fire, each tier of flats is entirely enclosed between brick walls, nowhere less than twelve inches thick, and it is thought probable that fire in any one section of this building could be prevented from spreading to any other section, as there are five fire-proof sections running from the first floor to the roof." Each of these sections may be shut off from the others by fire-proof doors. This is an excellent feature, which cannot be too highly commended. The first floor is constructed with iron beams and terra-cotta arches, as required by law, and the semi-fire-proof construction above this floor is claimed to be much better than the law requires. The stair-halls have cement floors, and there are two ways of egress from each apartment. Hot water is supplied from the cellar, and the plumbing throughout is open. All of this is praiseworthy, and we are prepared to admit that the architects, a New York firm, have very nearly achieved the object of the design, so far as conditions permit, one of those conditions being that twenty-two families should be crowded into the space above the ground-floor stores. The class of tenants obtainable for apartments of this kind will not average less than four to each family; therefore, we may consider that eighty-eight persons are to be accommodated—exclusive of the stores—on a ground-plan of fifty feet by eighty-eight feet and nine inches, out of which the area in plan for walls and partitions is to be taken. Taking the dimensions of the rooms as marked on the plans so far as they appear, and ascertaining by the scale the dimensions—not given—of the bath-room and closet, we find that a floor-space of less than ten feet square is allowed for each person, or a little less than ninety-one square feet per person in the four rooms and bath apportioned to each family on the second floor. These rooms are a living-room, two bed-rooms, kitchen and bath-room, with a single closet for wardrobe about three feet wide by nine inches deep. The bath-room, which includes the water-closet, is four feet square; the kitchen, which includes range and wash-tubs, eight feet six inches by eight feet eight inches. Less than nine hundred cubic feet of space per person are allotted. It may be that this is the best arrangement that is possible for people who are expected to live (like rats in burrows) in spans just large enough to permit their turning around; but the crowding of eighty-eight people into a space like this is to us not a very encouraging outcome of all the effort that has been put forth, and we do not think it ought to be so regarded by the public. At the first, when new and clean, such a building would, perhaps, contrast favorably with the older tenement-houses, and in some ways it would always be superior; but nothing would prevent its ultimate degradation into a den of squalor,—perhaps, also, of vice.

Gold in Siberia.

To the issue of April 3 of the *Mining and Scientific Press* Mr. Russell L. Dunn contributes a very interesting illustrated article upon gold mining in Siberia. While gold mining has been carried on in Siberia for nearly the same time as in California, it remains in its methods and appliances almost the same as when it began. There are no advances of note. While Siberia is a very large country and a large gold-producer in consequence, it suffers very much in this respect in comparison with smaller countries. The gold-bearing regions are scattered over an area of about three thousand miles east and west by one thousand miles north and south; besides, there is the Ural district, from which, notwithstanding its small size, comes a large part of the total annual production of Siberian gold. Mr. Dunn writes from personal observation, and he considers that the gold-bearing territory extends from the Yenisei river to the Pacific ocean, and from the southern limit of the Amoor drainage and the Altais, northward, till the foot-hills disappear about the Arctic circle in the swampy plains bordering the Northern ocean. So far, the method of placer mining is the only system that has prevailed. Only the shallow surface placers, such as were worked in the river bars and foot-hill gulches of California by the early gold-seekers, have supplied gold from these regions. These placers are many and scattered widely, and a few only are exceptionally rich. Mr. Dunn believes that he has observed conclusive evidence of quartz-lodes whose value is not appreciated by the Siberian miners. These lodes are similar in character to the California quartz-lodes, and the placers are situated not very far from their source in these lodes. The prospecting of these placers involves the thawing of the earth by artificial heat, in those parts of the country in which the ground is perpetually frozen. After the placer is located, it is worked in what are called "shurfs" sunk simultaneously on the placer, two men working at each shurf together. These shurfs are about seven feet square, being excavations carried down to bed-rock at depths ranging from six to twenty-five feet. Fires are built along the surface, softening the ground to a depth of about seven inches for each firing. The softened ground is then removed by pick and shovel. "When gold begins to appear in the ground, each successive seven inches of softened wash is deposited by itself by the side of the shurf, and marked with a stake, giving its depth from the surface. The foreman or engineer prospects these saved layers, and finally, with a seventy-two pound sample, washed either in the Siberian *batea* (a shallow wooden bowl about 22 inches in diameter), or in the Siberian sluice (which has its nearest comparison in a mortar mixing-bed), determines the weight of gold that a unit of 3,600 pounds of the wash will contain. This he marks on a rough plan-map of the shurfs, and also marks the respective depths of over-burden and of pay. This washing is usually done in the following summer. If sufficient gold is shown to pay, on working, other intermediate lines of shurfs are staked out,—about one hundred feet apart this time,—and in the following winter they are sunk, prospected the next summer, and mapped."

The Wellington Series Engine.

WE can do little more than simply call attention to the description of this invention presented in the *Engineering News* (April 8), which occupies nearly three pages of that journal. It will be remembered that, in the announcement of the death of the late A. M. Wellington in the spring of 1895 (at the time of his death editor of the journal quoted), mention was made of a remarkable invention upon which he was engaged, and upon which he had expended a very large amount of experimental work, which work was continued almost to the very last week of his useful and honored life. Whatever may be the outcome of this work in its influence upon the progress of mechanical engineering, it is without doubt one of the most interesting studies relating to heat engines conducted in recent years. Since each element of this system of engines consists of a boiler or vapor generator, engine, surface condenser, and means for re-

storing the liquid of condensation to the boiler, the novelties in the mechanical part of the system are in the line of construction, such as details of the boiler, means for effecting rapid circulation of liquids and vapors over the heating surfaces, etc. It is not new to use liquids volatilizing at a temperature lower than water for obtaining a vapor under working pressure by absorption of heat from the vapor of water at less than atmospheric pressure. In this way vapors at pressures higher than that of the atmosphere may be generated by water vapor whose pressure is lower than that of the atmosphere. The records of the American patent office will show a number of inventions directed to this purpose. For reasons upon which we shall not here enter, none of these inventions have come into general practical use. We shall not attempt to do more than give a general idea of the principles on which Mr. Wellington's invention rests. A heater delivers a liquid at 500 degrees to the boiler or vapor-generator of an engine wherein vapor under a working pressure is produced by extracting heat from the primary liquid and imparting it to another liquid which evaporates at lower temperature than that of the primary liquid, and wherein the primary liquid is cooled down to, say, 444 degrees; the primary liquid then passes along to another generator in the series, which generates vapor under less temperature and tension than that of the primary liquid, and wherein the latter is cooled down to, say, 388 degrees; and so on to the different generators of the series of engines, say, five in all, the temperature of the primary heating liquid being reduced in the last generator down to 220 degrees,—a mean reduction of 56 degrees for each vapor-generator. In passing through these generators, the heating liquid, going outward from the heater, imparts heat successively to the contents of each generator. The vapor produced in each generator of the series acts upon the piston of an engine, then passes over into one of a series of condensers, and is there condensed by the returning current of the same primary liquid going back to the heater. For, after having passed through the fifth or last generator, the circulating primary liquid flows through a surface-cooler, whereby its temperature is reduced from 220 degrees—the temperature at which it leaves the last generator—to 50 degrees, at which temperature it flows into the condenser of the fifth engine. Here it collects heat from the exhaust, its temperature being raised from 50 degrees to 97.6 degrees. Thence it passes into the condenser of the fourth engine of the series, where, in condensing the exhaust of that engine, its own temperature is raised to 145.2 degrees; so on through the condensers of the third, second, and first engines, arriving at the first condenser with a temperature of 240.4 degrees, and leaving it at a temperature of 288 degrees. Thence it passes again into the heater to regain a temperature increment by which it attains the original temperature of 500 degrees, completing the circuit. On its outer course from the heater to the cooler, the primary liquid gives off heat successively to the contents of each generator, which heat is successively converted into work by each of the serial engines; on its return from the cooler to the heater it takes up a portion of heat successively from each condenser. As it goes out, it is always hotter than the contents of the generator through which it passes; in the cooler its temperature is so reduced after passing through the last generator that thereafter it is always cooler than the contents of the condenser through which it passes, until it gets back again to the heater. The liquid of condensation is pumped back from each condenser to the generator whence it came, and the circulation of the primary liquid to and from the heater and cooler is also maintained by pumping. Suppose the primary liquid to be water, and the secondary liquid vaporized in the generator working the engine and condensed to liquid again in the condenser to be water, carbon disulphid, anhydrous ammonia, or other material capable of producing vapor or steam of working tension at a temperature lower than that corresponding to the same pressure of the primary liquid; it will then be easy to see

that such a system would be able to supply power so long as the primary heater and final cooler should maintain the stated difference of temperature. It can also be calculated that a much larger percentage of the heat imparted to the primary liquid (assuming that the theoretical temperatures could be maintained) would be converted into work than could be so converted by directly using the vapor of water in either a single or multiple-cylinder expanding engine; but, in so complicated a system of heat exchanges, it is too much to expect that the theoretical temperatures can be reached and maintained. There will be losses which, in the absence of actual experiment, cannot be estimated. The cycle can be proved to conform to the law of the Carnot cycle, the indicated power being a function of the difference between the high and low temperatures of the primary liquid. The mechanical features of the invention are interesting, the principal innovation being in the structure of the generators for producing vapor through the action of heat derived from the primary liquid, etc. The fact that heat is transferred very much more rapidly by a heated liquid on one side of a metallic septum to a cooler liquid on the opposite side than by a heated gaseous medium through a similar septum to a cooler liquid on the opposite side enables a very much smaller amount of surface to be used for the transmission of heat than is used with the ordinary steam boiler. We cannot here go into the details of this construction, but the extent of the innovation is indicated in the statement of our contemporary that "a boiler has actually been built and worked which generated forty h. p. with a weight and bulk only one two-hundreth as great as the ordinary stationary boiler of that power." It is added that, shortly after this boiler was finished, "Mr. Wellington hit upon an entirely new plan of boiler-construction, by which he hoped to go even farther in the direction above noted in the reduction of weight and bulk for a given power, and at the same time to make a boiler which could be constructed at a far less cost than the tubular boiler." All who knew Mr. Wellington, particularly his associate members of the American Society of Civil Engineers, will deeply regret that he did not live to advance further this his favorite study of improvement in heat engines.

Alternating-Current Dynamos in Parallel.

THE disadvantages of the prevailing system of running each machine on a separate circuit are set forth in the first part of a serial paper by J. E. Woodbridge in the *Electrical Engineer* (April 28). "The number of circuits increases necessarily with the number of machines, and the problem of properly distributing the loads on those circuits, so that in the evening each generator shall do its full share of the work, and yet not be overloaded by some unanticipated addition, is a serious one. A compromise which results in poor economy always has to be made with loads which are subject to sudden changes that cannot be foreseen in the central station, such as the theatre and church loads, etc. Then constant attendance is necesssary, as the load rises and falls through its daily range, to start up the fresh dynamos as they are needed, and switch on to them the different lines; and again, when the load falls off, to properly bunch the lines on certain dynamos, so as to keep the machines which are running always as near to their most efficient loads as possible. No little ingenuity is needed when the dynamos in the house are of various sizes and capacities. When the conditions are further complicated by the necessity of giving the longer feeders a higher voltage than the shorter ones, the increase in that voltage being proportioned roughly to the load, the switchboard man has no easy job. Added to that is the necessity of carrying over his circuits as nearly instantaneously as possible to prevent too long 'wink' in the lights; and the risk of accidentally throwing two machines in multiple by a mistake in the manipulation of his switches." A serious objection to independent alternators is this winking of lights, and it is spoken of as being one of the things favoring the introduction of the Welsbach gas-burner, whose comparative steadiness is one of its

chief recommendations. Mr. Woodbridge goes on to show that all the disadvantages which he has comprehensively enumerated are completely removed by "running all the alternators in a station in multiple on one set of bus-bars, from which all the feeders are tapped off, either direct or, in the case of long feeders, through adjustable boosting converters." He proceeds to show how the number of feeders can be thus much reduced and economy increased. For instance, "two No. 0000 lines cost less and give less trouble than the same amount of copper in eight No. 3 lines." He quotes the well-known experiment of Mr. Mordey as evidence of the entire possibility, as well as the commercial practicability, of running alternating-current dynamos in this way. The dynamos thus run will synchronize in speed, and will adjust the relations of voltage and phase (at least with the Mordey-Brush dynamos), running multiple under even more trying conditions than direct-current machines. The multiple method has been largely adopted in Europe, but has not been generally used in the United States. The large plant at Niagara is arranged to work in this way. This series of articles by Mr. Woodbridge shows that the idea that alternating dynamos must be specially made for multiple working is not broadly true, as most good machines of the same frequency will hold up to speed under a complete range of loads without excessive current, and will run synchronously.

Electric Lighting of the Armory of the Ninth Regiment N. G. S. N. Y.

THE lighting of this new old building, situated on the north side of Fourteenth street, New York city, between Sixth and Seventh avenues, and having a frontage of about 212 feet and a depth of 250 feet, presents some features worthy of notice. *The Electrical World* (April 3) gives considerable space to the illustration and description of the lighting installation, from which the following particulars are derived. There are 2,500 16 c.p. incandescent lamps in the various administration rooms, and 60 1,200-c.p. open-air Ajax arc lamps are employed for the illumination of the main hall. The arrangement of the arc lamps for the main hall is specially commended. "All the various fixtures, both for arc and incandescent purposes, are specially designed of wrought iron, and those in the main hall are also equipped with electrically-lighted gas-burners. Particularly in the main hall are two large clusters, each including twelve arc lamps, which are arranged in the form of a large chandelier centrally suspended from the center of the arches over the drill floor. The lamps, when raised, are about twenty-eight feet above the floor line." Ten single arc-lamp fixtures are arranged under each of two main balconies, these balconies being about sixteen feet above the floor. Over each end of the balcony are four single arc-lamp fixtures, twenty-one feet above the gallery floor. The lower part of each main fixture is a structure of metal work supporting a group of twelve arc lamps, each lamp suspended from an iron hook. The system appears to be an extension of that used in some of the buildings at the Chicago World's Fair, where arc lamps arranged in clusters, or "arkoliers," were used with great success. For lighting large spaces, this system presents some advantages. The "use of enclosed arcs also adds a number of features tending to increase the value of such methods. Lately, however, a number of very large halls have been thus illuminated with excellent results."

Eccentric Gearing.

MR. FRANK RICHARDS, in *American Machinist* (April 22), points out that this class of gearing has a merit not ordinarily attributed to it, the "quick return" movement being all that is generally thought of in connection with it; whereas, upon crank-actuated machines, the approximate uniformity of advance during the working stroke is, perhaps, of as great importance as the quick return. He exemplifies this by an eccentric gear diagram. Thus the planer can be run all the time at the best speed possible, which is, of course, with a well-designed machine, what the tool will stand for the whole stroke.

THE BRITISH PRESS

Architecture and Handicraft.

CITING two ancient authorities, Vitruvius and Pythius, Mr. T. C. Jackson, R. A., in a paper read before the Architectural Association in April (reported in *The Architect and Contract Reporter*, April 9), quotes both, and criticises both as to the importance of a knowledge of the handicrafts employed in building. Though Vitruvius is no longer in fashion as an architectural authority, the following opinion, expressed by that once vastly popular writer, serves as a text for Mr. Jackson's paper. "Architects who are mere handicraftsmen without literary training are unable to give a reason for what they do, while those who trust only to theory and book-learning without practical training seem to grasp at a shadow. . . . An architect must be properly trained in both fields. He must be both ingenious and teachable, for neither will wit without training nor training without wit make the perfect artist. He must be a skilful draughtsman, a learned geometrician, not ignorant of optics, instructed in arithmetic, a good historian, and a diligent student of philosophy. He must understand music, he must know something of medicine, he must be familiar with the decisions of the lawyers, he must understand astrology and astronomy." At one time all this would have been accepted as gospel. It shows the mutability of human standards that a writer of the present day may with impunity characterize it as "nonsense." While, in the same way that the knowledge of many of the things named benefits any one, they may benefit an architect, they are not essential to his success as an architect, any more than they would be to a navigator or the general of an army. The enumeration is a queer mixture of essentials with non-essentials, and its sweeping character is much modified by Vitruvius in his category of the uses which the knowledge named can be made to subserve in the practice of the architectural profession. Even this enumeration is much narrower than that given by Pythius, who, in the opinion of Vitruvius, goes much too far. Vitruvius admits that "it is only now and then that a man can excel in one art, even if he pursues no other. He has done quite enough in these several branches of study who has a fair knowledge of those parts and theories of them which are necessary to architecture." In other words, this all simmers down to the obvious truism that an architect needs to know the essentials of his art. But what are these essentials? Mr. Jackson asserts "that of late years there has been a revulsion against what he styles the Roman method of practising architecture, in favor of the Greek method. Many . . . have been preaching against the strictly professional view, and urging that a man cannot be expected to produce good designs who seldom or never comes into contact with the materials of which his design is to be constructed. We have argued that it is from the handling of material that suggestions in design can most readily be gathered; that reading about processes in building, or any of the arts that go to make up a building, will never teach a man to make the most of his opportunity . . . and how to design in accordance with the natural qualities of the material with which he has to deal." Mr. Jackson points out that these proposals, though they may seem revolutionary to the advocates of the established professional system, would, if adopted, still be far from bringing us again to the methods of the architects of four hundred or five hundred years ago. He avers that the contracts of the earlier period bound architects much more rigidly to a constant and intimate association with their work than modern architects would submit to. "The architect bound himself to come with his family and live in the place where he was to build; to engage workmen, and see that they did all that was necessary to be done; to work with his own hands, both in building and in sculpturing, as befitted a good sculptor and a master of the art of stone-cutting." A part of his duties was to visit the quarries and superintend the

quarrying of the stone; and he was restricted from undertaking any other work for the term of years covered by the contract without special permission of his employers, which, if granted, specified the exact amount of time he could employ upon such work. He was the "chief master-builder and superintendent of all the laborers, builders, master-workmen, and handicraftsmen employed on the building," and supplied the necessary dimensions, orders, and methods. Instead of being paid a commission, he was paid a salary for the term of service, with sometimes some added perquisites. The multitudinous details of the modern architect's office-business were unknown to the mediæval architect. Personal interviews with employers on the spot where his work was in progress rendered much letter-writing needless, and he could concentrate his uninterrupted attention upon the single job in hand. Long and tedious hours grudgingly given to railway journeys were unknown to him. The power to change anything during the progress of the work was constantly at his command. While this state of things cannot be reëstablished in a hurry, or even at all, Mr. Jackson implies that it is a good thing to recall it, and he believes the modern architect may, if he will make the effort, get more into touch with the handicrafts, and that the practice of the art would benefit by the effort. On this line he completes an interesting paper with practical suggestions.

Connection of the Black Sea with the Baltic Sea.

ACCORDING to *The Engineer* (April 9), the scheme of connecting these two seas by a canal of capacity sufficient to permit the passage of the Russian war-ships, under plans and specifications prepared three years ago, which scheme was postponed on account of the death of the czar, has again come up for consideration. There is an unmistakable purpose to construct this canal, of which we condense a description from the contemporary named. The route proposed is from the Gulf of Riga along the rivers Duna, Beresina, and Dnieper, to Khershun in the Black sea. The length of the course is 994 miles. The canal will consist, when completed, of the deepened channels of the rivers named and new cuttings to make a continuous water-way having a draft of 28 feet. The estimated cost will be £20,000,000. It is estimated that five years will be necessary to complete the construction. The object of the canal is to connect the dockyards at Libau in the north with those at Nikolaieff in the south, so that war-vessels can be moved in a short time from one point to the other. As a collateral advantage, it is expected that a rich tract of country will be developed along the line of the canal, and that the water-way will become important as one of the great avenues of commerce. The region through which the canal will pass, and which is watered by the tributaries of the rivers named, is said to be fertile, and there are also mineral lands which will contribute to the traffic, the bulk of which will be in corn, timber, iron, salt, and hemp. Reference to any good map of the country will show that the Duna, or West Dwina, empties into the Gulf of Riga at Dunamunde, and is navigable to Velig, 400 miles from the mouth. The total length of the river is 650 miles, and its drainage area 28,350 square miles. At its mouth it is about a half a mile wide. At about 90 miles from the mouth the river has risen 280 feet above sea-level, and at the summit 511 feet. The channel is shallow and much obstructed by sand beds and rocks, and it is difficult of navigation, except during the autumn and spring floods. It is generally clothed in ice from November to April. The Beresinski canal, constructed in the latter part of the eighteenth century, connects the summit level of the Duna with the river Beresina. Traversing a portion of the river Ulla and the lakes Beloje and Beresina and the river Sevgatcha, connection is made with the Dnieper at an elevation of 385 feet above sea-level. The Dnieper, in the length of 1,000 miles, drains an area of 204,000 square miles. Fifty miles below its source it is 200 feet wide. Four hundred miles from the out-fall its width is 1,500 feet. It discharges into the Black sea through nine mouths, and the deepest water in any of

the channels does not exceed 10 feet. It is clothed in ice from January to March. It is expected that the greatest difficulties in the construction of the canal will be met in the upper part of the Dnieper, which passes through marshy and wooded country. The strategic advantages of the canal for naval purposes will be supplemented by the commercial advantages in the transport of produce from, and the development of, a rich agricultural and mineral country.

American Trans-Atlantic Telegraphy.

THE affairs of the American Commercial Cable Company, its present status, and the nature of its service, form the burden of an interesting article in *Engineering* (April 2). The origin of this line is referred to the need of obtaining cheap and abundant telegraphic matter from London every night for publication in the *New York Herald* on the following day. The proprietor of this paper, Mr. James Gordon Bennett, enlisted the coöperation of Mr. Mackay of San Francisco, and established the line, which immediately entered into competition for general telegraph business between the two continents. The enterprise has now acquired the property of the Postal Telegraph Cable Company. "The Anglo-American Telegraph Company, Limited, thought it had made a good stroke when it established intimate relations with the Western Union Telegraph Company, and the latter has been buying up competitors of all kinds for the last thirty years. It is a fruitless task, however, to endeavor to extinguish American competition, as no sooner is one company absorbed than another presents itself. The capital stock of the Commercial Cable Company stood, at the close of 1896, at $10,000,000, and the dividends for 1893, 1894, and 1895 amounted to $700,000 in each year, while for 1896 they rose to $800,000. In other words, the proprietors received last year a return upon their capital at the rate of 8 per cent. per annum. The net revenue of the company amounted in 1893 to $1,057,747, in 1894 to $1,010,438, in 1895 to $1,215,308, and in 1896 to $1,176,565. The increase in the amount distributed in dividends last year was due to the declaration of a bonus of one per cent. in addition to four quarterly dividends of 1.75 per cent. per annum. After paying these dividends, the company was able to carry forward a balance of undivided profit of $846,678. The reserve fund was also increased last year to the extent of $250,000." The reserve-fund account had a credit at the end of the year of $2,041,821. The revenue of the company increased during the year $9,518, but the working expenses increased $48,350. The increase in working expenses is attributed to extensive repairs carried out during the year. From these facts it is inferred that the affairs of the company are in good working condition, and that it has certainly become one of the permanent lines between the two continents. At the same time *Engineering* regards it as doubtful whether English investors will take kindly to the Commercial Cable Company. It concedes, however, that it is the "most persevering and carefully-administered American Atlantic telegraph company with which the Anglo-American Telegraph Company has ever had to contend. . . . The English Company crossed swords in its day with the redoubtable Jay Gould, but he was soon bought up. The Paris and New York Telegraph Company had also not been a particularly serious opponent, but the Commercial Cable Company is a different kind of an affair altogether." At the same time, it is claimed that the affairs of the Anglo-American Company are slowly improving, although there is much yet to be desired. The Commercial Cable Company has a capital of less than one-third that of the Anglo-American Company, but earns nearly as large an annual profit as the latter. Hope is expressed that the future of the Anglo-American Company will be improved by the gradual increase of telegraphic business. While the Commercial Cable Company has built up a good business, the Anglo-American Company has also been picking up, rather than losing, for the last three or four years. This indicates a vital tendency toward increase in telegraphic communica-

tion between the continents. It is regarded as all the more significant that it has occurred during a period of great financial depression in the United States. It is therefore argued that transatlantic telegraphy is destined to become more remunerative as time elapses. The affairs of the Commercial Cable Company display admirable management, and its prosperity will be a source of pride to the American people.

Increased Consumption of Coal Gas.

IT was at one time believed that the manufacture of coal gas was likely to be greatly injured as an industry by the introduction and extension of electric lighting. It is probable, however, that, if statistics of production were consulted, the industry would be found to have increased considerably. It is likely that the amount of gas used per head for lighting, inclusive of street-lighting, is less than it was twenty-five years ago, but the populations of countries wherein gas is used as an illuminant have considerably increased, and during this period the uses of gas for warming apartments, cooking food, and for power, have come to be extensive, and are each year increasing. In a serial by Thomas Fletcher, begun in *The Gas World* (April 3), the commercial uses of coal gas are stated, and many interesting facts connected therewith are set forth. Among these the extension of the use of gas for industrial purposes other than light and power is one of the most interesting. Thus gas is used, among other things, for press heating, calender rolls, branding machines, boot-finishers' and book-binders' tool heating, bakers' ovens, in the wire trade, wire-cable-making, and in welding lead sheets in the manufacture of acid chambers and lead cisterns. It is also used to supply heat for melting solder in soldering machines, and for other purposes. These uses appear, on the whole, to have more than compensated for the competition with electric lighting, so that the gas industry need no longer fear such competition, unless, as seems improbable, very much cheaper methods of generating the electric light shall be discovered.

Salt Water in Water-Tube Boilers.

FOR a long time after the introduction of water-tube boilers, it was held to be almost axiomatic that they could be used with fresh water only. The evils of priming, salting, and even of plugging the tubes with salt, were assumed as certain to accompany the use of sea-water in a boiler of this type. It is to be confessed that such an inference was based upon good grounds, and that confirmatory proof has not been lacking. *The Engineer* (London, March 12) editorially discusses and describes some experiments carried out by Messrs. Yarrow & Co. to determine whether, in spite of the general opinion, the use of sea-water temporarily in such boilers, in cases of emergency, would be practicable. The first experiment dates back to 1888 or 1889, with the original experimental water-tube boiler made by the firm named. This boiler "is a small generator, with two separate steam drums and two lower chambers." It was set up in the yard of the works, and supplied with clean sea-water brought by railway from the coast for the purpose, and steam was generated at atmospheric pressure. A continuous run of forty hours was made. During the run the boiler did not prime, but about two dozen of the tubes (one inch in diameter and four feet long) "were salted up solid." There was no scumming or blowing off of the water. "The tubes being straight, it is comparatively easy to drill the salt out with a species of augur, or twist drill, made for the purpose. We have seen," says *The Engineer*, "a tube thus cleaned in a very short time; and, so far as we could see from careful inspection, if the tubes were thus cleaned, the boiler would be ready for service." With all respect for the opinion of our esteemed contemporary, we submit that, after such an occurrence in a tubulous boiler, nothing short of a hydraulic test could prove that it had passed uninjured through the trial. In another place it is tacitly admitted that there was bending and distortion of the tubes; this would at once, in our opinion, indicate that, however well the boiler looked in other respects, it would be apt to leak under pressure. Neither is it ap-

parent from this experiment that, had this been "a real torpedo-boat boiler, such a boat could have steamed four hundred miles at ten miles an hour," on salt-water feed, as asserted in the article reviewed. Only an experiment with salt-water-supply under precisely the practical conditions of marine propulsion could determine the practicability of using salt-water feed for even a temporary service. Such a test, recently made by the same firm, is conclusive as regards short runs, with a torpedo boat, since it lasted four hours and fifteen minutes. What would have happened had the run been extended to forty hours cannot, in the absence of such a run, be predicted. What did happen was that, when salt water was first fed to the boilers, there was some priming. The boiler pressure being maintained at two hundred pounds, and the steam being wire-drawn to one hundred and fifty pounds, comparatively dry steam was obtained, and the water remained more steady in the boiler. Under these conditions a speed of about seventeen knots, with 250 h. p. developed, was attained, according to estimate, though no diagrams were taken. Our cotemporary states that this is but one of several runs made with salt-water feed by this boat, with examination of the boiler after each run. "Instead of the heating surfaces being heavily coated with lime salt adhering, they are coated with a loose deposit crumbling away under the fingers and readily brushed off from the surfaces. There is some reason to think that at high pressure the lime salt, instead of adhering, like cement, to the metal, comes down as a non-adherent powder, which can be easily washed out." We should not like to accept this view without further experimental evidence. Neither would we be able to accept the opinion that, with proper blowing-off and scumming (purposely omitted in the short trials), a Yarrow boiler could be "run for a month without trouble." This can be proved only by a month's successful run on salt-water feed. Theory and personal judgment alone cannot be relied upon in a matter of this sort, where so many unknown quantities may become factors.

Efficiency in the Arc Light.

THIS subject is discussed in a paper by Thomas Hesketh (*The Electrician*, April 9), in which he reduces the factors governing the quantity of light as related to the energy consumed in producing it, roughly, into two,—to wit, the diameters of the carbon and the length of the arc. He states that the rule which has been formulated from the experiments of Herr Schreihage errs on the side of underestimation, in that it makes the light of the arc vary in inverse proportion to the carbon diameters. "Tests taken by M. Jean Rey with a 20-ampere direct-current lamp, with two pairs of carbons 21 mm. and 13 mm., and 14 mm. and 8 mm., respectively, resulted in no less than *three times* the volume of light from the smaller pair for the same electrical energy. These results, together with the lesson they teach, are not difficult to realize, when one considers the point from which the emission of light takes place. The first and most obvious improvement is to be produced by the reduction of the negative carbon to the smallest possible extent. By this means the crater of the positive, which is the actual source of light, is less shielded, and more rays are free to escape. This enhancement has already been effected in the majority of our better lamps, but not to so great an extent as the case warrants and demands. It must not be imagined, however, that the increased efficiency resulting from the reduction of the carbon diameters is due to this cause alone." Mr. Hesketh points out that the main effect is due to confining the heat of the arc to the smaller body of carbon. There is also a reduction of heat loss through conduction and radiation. For these reasons, the author maintains, "the lamp of the future must burn smaller carbons." There are, however, limits to this rule which he does not overlook. One of these is "the increased length of rod consumed for the reduction in its diameters"; but, if our station engineers would consider the amount of light gained, and not be wholly influenced by the lamp-trimmers' wages, we should soon have our street-lamps burning with half their

present size of carbon. In some parts of the continent lamps are nightly in use with a 20-ampere arc perfectly maintained between carbons of 12 mm. and 10 mm. diameter." Surprise is expressed at the cost of the light thrown away in England by the use of the larger carbons, in comparison with the slight increase in wages necessary in order to trim and carbon lamps with carbons of smaller diameter. Mr. Hesketh thinks that the advantages secured in the distribution of light from a long arc can well be left out of consideration, until the full advantages of reducing the diameters of the carbon have been realized.

Casting Direct from the Blast Furnace.

THE possibility of casting direct from the blast furnace has often been considered, and to some extent discussed. The fact that this system has never been generally adopted shows, however, that the idea has not been very far advanced. Mr. W. H. Butlin, in *The Iron & Coal Trade's Review* (April 2), takes up the subject again, and argues, not only from general principles, but from his own experience, the practicability of this method. To the article (which is one of considerable length) the editor of the journal quoted appends a note, stating that Mr. Butlin accompanied the article with specimens of the castings which he refers to, which were placed on view at its offices. Mr. Butlin says that hitherto the drawbacks to this system have been considered too great to permit of its direct application. The intervention of the cupola has been considered necessary, on account of the variable quality of the metal, except for the more important uses. He believes, however, that this is an erroneous conclusion, and asserts that, with careful scientific treatment, he has been able for a long time past to produce good, sound, soft castings, uniform in quality and capable of standing the test of the hardest wear possible about an ironworks. These castings have been successfully used in tip-wagon, furnace, barrel and bogie wheels, valve seatings, and other engineering works. The results are due to scientific mixtures and a chemical knowledge of the materials employed. "Iron is iron, but it may be largely influenced by the foreign substances alloyed with it in the form designated cast-iron. The salient characteristics of the metaloids associated with it must largely determine its quality according to their preponderance, but, in the writer's opinion, we may, chiefly for the purposes of investigation, ordinarily limit these to three,—*i. e.*, oxygen, carbon, and silicon. Oxygen is present from the oxids, principally of the ores smelted, and is also contained in the air or blast; carbon is present from the fuel or the carbonates either of the ore or limestone; silicon is present from the silica of the ores, etc. We may perhaps neglect the influence of manganese in Northampton ores, as usually the amount present is only a fraction of one per cent." Mr. Butlin quotes Mr. Robert Mushet in support of the opinion that all iron which has been too much oxidized in smelting can be restored by treating it with carbon. At least, Mr. Mushet so regarded the "overblow" in the converter steel process. "In the blast furnace there is, of course, always the preponderating influence in a reducing atmosphere of the carbon oxid modifying the oxygen effect; but here it will be well to notice that temperature plays an important part. Carbon, I think, most readily combines with iron at comparatively low temperatures, as often noticed in the cooling effect of scrap added to a hot furnace when promoting grey iron and abundance of graphite. Silicon seems to have baneful effects at high temperatures." From these facts Mr. Butlin assumes the hypothesis that carbon at a low temperature, and silicon at a high temperature, have greatest influence upon the character of the metal. "We know that, when a certain amount of silicon is present, grey iron is made more readily (*ceteris paribus*), but I think we need to have the required silicon present at low temperatures relatively, that carbon may exert its greatest influence and deposit graphite in the pig metal." Fusibility must be studied, and the most fusible slags are those of the more acid type. Foundry iron produced from these will be considerable in quantity, if low temperatures are used, consistent with their acid type. To

obtain the requisite fluidity in accordance with chemical composition and temperature requires experience, based upon knowledge of the materials employed. Mr. Butlin thinks these are worth working for, and he states that they are "surprising to the novice when viewed beside a miscellaneous use of the same materials unaided by the scientific method." His views with reference to temperatures are radical. "I hope that I may not be accused of a too daring hypothesis in expressing an opinion favorable to the employment of temperatures within the range of pipe stoves as aiding quality," with "ores suitable to the formation of the more acid type of slags. Why treat tender, friable, and fusible ores with the greatest temperatures attainable? —no doubt, with a certain dubious economy; but such a method cannot be understood, much less appreciated, unless the object aimed at be mere quantity at the entire expense of quality." It is maintained that the greatest quantitative yield with good quality and uniformity cannot be attained by excessively high temperatures. The concluding portions of the paper give further reasons for this view, for which the article itself must be consulted.

Coal Production and Consumption in Different Countries.

SOME very interesting facts and statistics are given editorially in *Engineering* (March 26). These are prefaced by the remarks that the use of coal *per capita* is an erroneous basis on which to estimate the advancement of civilization in a particular country. For instance, in Russia, much wood and oil are used as fuel for mechanical and manufacturing purposes; and similar influences affect more or less the consumption in the United States. In the United Kingdom the average consumption is 3.75 tons of coal per annum for each individual. In Russia it is only 0.1 ton per annum per individual. In the United States it is about 2.44 tons. In Sweden something less than 0.5 ton. Belgium consumes per individual 2.66 tons per annum; Germany 1.38 tons; France 0.95; and Austria-Hungary 0.33 tons per individual. Spain and Italy consume per individual something more than Russia, the quantity being for Spain 0.19, and for Italy 0.15 ton. The conditions of consumption are stable from year to year, but improved practice in steam engineering affects the result more or less in countries wherein steam is largely used. Attention is called to the fact that in England, although coal is cheaper than in most countries, a constant effort for greater efficiency in its consumption is made. The growing practice of using gas in the kitchens of private dwellings for cooking purposes is reducing the consumption of coal in both England and the United States, the intermittent use of gas enabling it to be economized more than coal can be. The increase of consumption in England *per capita* is stated to have been about 2 cwt. in twelve years. At the same time there has been a considerable extension of mechanical power during the period. Germany has increased her consumption in the same time 0.32 ton *per capita*, and it is thought that this is mainly due to the increased iron production. Belgium has increased its annual consumption in the twelve years 0.11 ton *per capita*, France 0.14 ton, Russia 0.04 ton. Japan has increased its annual consumption 0.04 ton *per capita* in the same time, its present annual consumption being 0.06 ton. A marked advance has taken place in the United States, which has increased its consumption in the time named by 0.53 ton per individual. This is accounted for by greater iron production, increased use of mechanical power, and the falling off of the output of natural gas, which for some years has been largely used as a substitute for coal. The total increase of consumption in the United States per annum has been 68,000,000 tons in the period named, which represents in power a production of 1,700,000 i.h.p. It might also be estimated in increase of production of tons of iron, and would in that way represent from 70 to 75 million tons. The point is made that the United States now use more coal than is used in the United Kingdom, the annual consumption in England being 146,750,000 tons. The increase

in Germany during the period named has been 23,000,000 tons. Whereas, twelve years ago, England burned three tons of coal where Germany burned one, Germany now uses two tons for every three used in England. The increase in England has been only 12,000,000 tons during the period under consideration, but it is claimed that this does not by any means represent the advance in England, which has rather been in the line of efficiency than in the quantity consumed, The consumption in all Europe exceeds that in the United Kingdom by about 15,000,000 tons. "Consumption is, however, not to be confused with production, and here England still excels even the United States, although it must be confessed that they are moving steadily forward to first position . . . . They have not, however, entered in any seriousness upon the export trade (their shipments are 2.5 million tons), but in this fact there is not much satisfaction for us. It would be better for us if we could utilize still more of our coal, rather than send such a surplus as 43,000,000 tons to other countries. What we want to export is manufactures, not raw material. Of course, much of this coal goes to our colonies; but over 18,000,000 tons goes to Europe, a large part probably to support competitive manufactories." Germany has increased her production in twelve years from 55,940,000 tons to 79,160,000; Belgium has increased her output from 18,100,000 tons to 20,400,000; France has increased her output 7,000,000 tons, but she still has to import 9,000,000 tons. Her increased output is almost entirely absorbed at home. In Russia the greater part of this increase in consumption is the product of Russian mines, the output having risen nearly 4,500,000 tons during the period, while the imports have remained almost stationary. The British colonies, with the exception of New South Wales, use about half a ton of coal *per capita* per annum, but they import a large proportion of this consumption. New South Wales, while using nearly as much as all the other colonies put together, exports more than 2,000,000 tons. India imports about 700,000 tons and uses about 3,500,000, so that she produces nearly 3,000,000 tons. There has not, however, been any improvement in consumption *per capita* in India, the consumption having simply kept pace with the increase in population. As to cost of production, the latest returns in the United States show that 4s. 6d. gets a ton of coal in the United States, while in England 6s. 0.5d. is required. From this fact, the possibility that the United States will largely increase its exports of coal is inferred. Its effect also in increasing mechanical power and cheapening manufacture is noted. The cost of producing coal in Germany has recently been about 6s. 9.75d. In Belgium the cost of coal is 7s. 6.75d.; in France, 8s. 10d.; in Hungary, 8s. 9.5d.; in New South Wales, 5s. 10d., and in other colonies it varies from 8s. 2d. to 12s. 2d. Notwithstanding the fact that in England the cost of coal-getting is greater than it is in the United States, England exports most of the foreign coal purchased in European markets. The less cost of getting coal in the United States is attributed to the greater use of coal-getting machinery.

Architects as Interior Decorators.

A PAPER read by Mr. T. Butler Wilson before the Leeds and Yorkshire Architectural Society (*Architect and Contract Reporter*, London, April 9) urges that interior decoration and furnishing should be brought under the control of the architect who designs a structure requiring such decoration. He says that, as regards this matter, "the architect stands aloof in silence,—anything but a dignified silence,—and allows the trade to deal with things which should be to him the most interesting and important duties of his profession." One reason for this state of affairs is found in the fact that "the public is not quite sure of the architect as a decorative artist. The few and notable members of the profession who have distinguished themselves in this branch of art are regarded as exceptions that prove the rule of general mediocrity."

THE FRENCH AND GERMAN PRESS

Electric Motors in Textile Industries.

THE application of independent electric motors for driving various machines is on the increase in various lines of the work, and is probably extending more rapidly in this country than in Europe. In the textile industry, however, independent electric-driving is found most convenient, and *La Revue Technique* for March 25 gives several examples of such driving, both in France and Switzerland.

In the well-known silk mills of Zurich and Rüti a number of looms are operated by independent motors with satisfactory results. The motors used are of the three-phase type, constructed by the Oerlikon works, each motor being placed on the floor directly beneath the pulley of the loom. The motor pulley is belted to the loom pulley, the motor being hung in a pivot frame, so that its weight gives the necessary tension to the belt, the whole being under the immediate control of the loom-tender. The controlling lever is arranged so as to stop the motor (in the manner in which the belt is shifted in the usual arrangement) if the loom should "knock off," thus preventing accidents to the fabric. In some cases each motor is used to drive several looms, the weaving room being fitted with short cross-shafts overhead, and each shaft having its own motor, the looms being belted from the shafts in the usual manner.

One of the most interesting of the changes which may be effected by the use of electrical transmission is seen at Saint-Etienne, where a company has been organized to distribute power to the houses of the ribbon-weavers. The ribbon industry employs a great number of workmen who have heretofore operated their own looms by manual labor at their homes, each house or apartment containing two or three looms. A single motor of ¾ h. p. is sufficient to operate three looms, and a large number have been introduced for this purpose. Already more than 1,200 looms are thus operated, and, the original power plant of 900 h. p. being entirely taken, a second installation of 1,000 h. p. is now being planned.

The social effect of this movement is worth considering, as it may be the manifestation of a powerful rival to the factory system, which otherwise bids fair in many localities to extinguish the individuality of the workman altogether. When the skilled workman is his own employer and the master of his own motive power, many of the labor problems which are the artificial creation of the factory system will find their own solution.

Freezing-Processes for Excavation.

LA REVUE TECHNIQUE for March 25 contains a *résumé* of the various processes for the utilization of freezing to enable excavations to be carried on in quicksands and water-bearing strata, and, although such processes are well known in America, the article is worthy of notice here.

Probably the earliest application of cold for this purpose was made in the Siberian mines, it having been employed there from time immemorial by the Samoyedes. The object there is to reach the gold-bearing rock, which is in many places beneath strata of gravel and sand containing watery seams, and the somewhat primitive method is to use the natural cold of the winter season. The ground is kept clear of snow, so as to permit the cold to penetrate as deeply as possible, after which the surface is thawed by fires until a shallow layer of earth can be removed. The freezing is then allowed to proceed, and the thawing operation repeated, and this is continued as long as the cold weather lasts. In this way, through the long Siberian winters, open excavations are made to the gold-bearing rocks, the depth attained being from twenty-five to seventy-five feet, according to the duration of the cold season.

Artificial cold for purposes of excavation was used first by Poetsch in 1883; by his well-known process of the circulation of cold brine through a series of buried pipes the most difficult quicksand

may be made hard enough to be excavated like rock. In the article under consideration are given general illustrations and details of the apparatus used in sinking the shaft at the Courrieres mines, together with formulas enabling the safe thickness of frozen wall to be computed for round or square shafts of any given dimensions.

Among the important applications of the freezing-process are noted the sinking of the shafts for the cylinders of the hydraulic elevator for the canal lift at Les Fontinettes, and the construction of a tunnel at Stockholm. The latter work was executed entirely by the introduction of cold air into the working-chamber at the head of the tunnel, the cold preventing the infiltration of water until the béton lining was built, and the work of excavating and lining being carried on at temperatures ranging between 0°, and 25° F.

Apparatus for Disinfection.

IN the issue of the *Gesundheits-Ingenieur* for February 28 is given an illustrated description of the building and apparatus for the hospital for epidemics at Brünn.

Besides the use of steam for disinfecting clothing, the problems to be solved in the plant were as follows:

All the water from the baths and washing from the three pavilions of the hospital, as well as the condensed steam from the disinfecting chambers, were to be rendered harmless before being discharged into the drain-pipes, which led away to a gravelly tract, through which the water was to find its way to the river Schwarzawa. Also all the discharges from the patients were to be burned. To these necessary requirements it was also decided to add such features of construction as would enable the heat generated to be utilized for warming the pavilions and to supply the drying-room of the hospital laundry.

These results have been successfully accomplished with very simple means. The sterilization of the wash-water is performed in a horizontal tubular boiler, practically arranged as a hot-water-heating boiler, except that the circulating feature is omitted. The water from the pavilions passes into the boiler, where it is heated to a temperature of 212° to 230° F., and, after flowing through the heating pipes in the drying rooms and pavilions, is allowed to drain away to the river, thoroughly sterilized and harmless.

The boiler is provided with a peculiar setting, the furnace being placed in front, and constructed somewhat like a Siemens gas-producer, with steeply-inclined main grate and smaller horizontal grate at bottom. A deep bed of coal is maintained, thus furnishing a supply of gas which is delivered into a combustion chamber. Above the combustion chamber is a funnel of brickwork, into which the solid discharges which are to be consumed are fed, having first been mixed with peat. The arrangement of this funnel is such that all the matter is thoroughly dried under the action of a down draft, and, falling upon the lower part of the grate directly in the path of the fuel-gas, the dried mixture is very completely incinerated, the gases of combustion all passing through the tubes of the boiler and rendering up their heat to the water.

The entire apparatus, including the drying-room for the laundry, is placed in a building entirely separate from the hospital pavilions, and the washed garments are thoroughly disinfected in a Thursfield apparatus before being taken to the drying-room. The sanitary and engineering details of the entire installation appear to have been very carefully worked out, and the plant has been found entirely satisfactory in practice.

The Wiborgh Thermophone.

THE Wiborgh Thermophone, about which some general information has already appeared, is very thoroughly discussed in the *Oesterr. Zeitschr. für Berg- u. Hüttenwesen*, for February 20, by Herr von Jüptner. The principle of the thermophone is that of the time required for a given amount of heat to penetrate to the center of a mass of fire-clay, graphite, or other resistant material. A small cylinder of, say, fire-clay has in its center a little pellet of a specially-prepared explosive,

which, when heated to a predetermined temperature, will explode with a characteristic report. If a number of these cylinders are made, all as nearly alike as possible, and exposed to different high temperatures, it is evident that the time which elapses between the exposure to the heat and the sound of the explosion may be considered as a function of the temperature.

Having determined upon a standard size and uniform material for the thermophones, Prof. Wiborgh has determined, partly from empirical data and partly by theoretical considerations, the relations existing between time and temperature, and computed very complete tables giving the time corresponding to every ten degrees of temperature. With these tables and a stock of thermophones, it is necessary only to throw one of the little cylinders into the space of which the temperature is to be measured and note the number of seconds which elapse before the report is heard, when the approximate temperature may be taken at once from the tables.

It is found, however, that the time varies somewhat, according to the character of the surroundings, being different, for instance, when the thermophone is exposed to flame, or when placed in contact with the surface of molten metal; hence three tables have been computed for use with varying conditions. For flues, heated gases, etc., the best method is to insert an iron tube, closed at the inner end, and, after the tube has attained the temperature of the gases, drop the thermophone in, and note the time before the explosion. A similar tube may be used for melted metals of moderate temperatures, while for metals of very high fusing-points the thermophone is thrown directly upon the surface, in each case using the corresponding table.

Judging from results given by Herr von Jüptner, the determination of temperatures by this means is not so precise as with the higher grates of pyrometers, such, for example, as the Le Chatelier instrument; but the simplicity of the thermophone, and the readiness with which it may be used anywhere for preliminary investigations, should make it a useful auxiliary to more accurate, but more complicated, apparatus.

The Kyffhaüser Monument.

WE have referred in these columns to the disappointing character of the designs submitted for the Leipzig monument, and are glad to be able to express a different opinion of the noble design of the impressive Kyffhaüser monument, by Prof. Bruno Schmitz, of Berlin. The completed monument, as illustrated in the *Deutsche Bauzeitung* for February 27 and March 6, shows several modifications in the original design, and, judging from the reproductions of photographs, both of the entire monument and of various details, the work is most worthily conceived and admirably executed.

The fundamental idea of the monument —the fulfilment of the ancient prophecy of the return of the sleeping Barbarossa to restore the empire to Germany, in the person of the Emperor William I,—is emphasized by its erection upon the historic Kyffhaüser mountain, the traditionary rock within which still sleeps the Barbarossa of myth and legend; and both architect and sculptor have embodied the spirit of the story in the work.

The rugged stonework of the approach, composed, as it is, of blocks hewn from the mountain behind, makes an admirable introduction to the first view of Geiger's noble statue of the seated Barbarossa, and the dignified imperial figure strongly suggests the Moses of Michel Angelo, both in pose and expression. From the severe tower above, typical of the reconstructed empire as signified by the imperial crown which forms the summit, rides forth the founder of the new empire, the whole forming a realization in stone and bronze of history and legend, past and present.

European Warships.

IN view of the present relations of the powers of Europe, the comparison of the naval strength of the various continental nations, as given in an article in *Stahl und Eisen* for April 1, is of interest. The article is accompanied by a fac-simile of the large chart prepared by the hand of the emperor of Germany, showing the comparatively meager preparations which Germany has made to increase her naval

strength, and intended, doubtless, to justify the appeal made to the reichstag for greatly-increased naval appropriations. The German navy has fallen behind in nearly all the departments, compared with the plans which had been made for its growth, and, if Germany is to maintain her position, something must be done to supply the deficiency; else the pretence of maintaining a first-class navy must be abandoned.

The following table shows clearly the status of the leading continental nations, and also the relative strength of the triple alliance of Germany, Austro-Hungary, and Italy as compared with the united strength of France and Russia.

	Battle Ships.	Coast Defence Vessels.	Armored Gunboats.	Armored and Protected Cruisers.	Despatch Boats.	Torpedo Catchers.	Torpedo Boats.	Unarmored Vessels.
Germany.....	11	8	13	14	10	10	89	24
Italy.....	12	5	—	19	15	3	138	22
Austro-Hungary.	13	..	—	6	7	7	68	11
England.....	57	16	—	135	4[illegible]	90	101	50
France.....	26	14	8	44	19	13	239	36
Russia.....	19	14	14	17	—	14	179	29
France over Germany.....	15	6	—	30	9	3	150	12
France & Russia over Triple Alliance.....	9	15	9	22	—	7	123	8

Decimal Time.

THE question of the decimal subdivision of time is again being discussed in France, in view of the approaching session of the commission having the matter in charge. *Le Génie Moderne*, in its issue of April 1, gives a brief review of the discussion at the last conference. The subject was regarded from two points: should the day still be divided into 24 hours, and the decimal subdivision be applied only to the hour, or should the day be divided into 10 or 20 hours? It was the unanimous opinion of the commission that the 24-hour division of the day should be retained, but that the hour should be divided into 100 subdivisions, and these further divided into 100 parts, names for these new parts being yet to be devised; also that the hours should be counted continuously from 0 to 24. The present session is to be occupied principally with the centesimal division of the circle, and with the preparation of a definite report upon the whole subject. This will include suggestions as to the best methods of putting the proposed changes into effect in France, and probably the submission of the matter to an international conference.

It will be remembered that the decimal division of time was one of the reforms attempted by the National Convention at the time of the establishment of the revolutionary calendar in France, the decree of the Convention of 4 Frimaire, in the year II (November 24, 1793) having divided the day into 10 hours and the hour into 100 divisions and 10,000 subdivisions. The plan did not meet with success, as the popular sentiment in favor of the 24-hour division of the day was too strong to be overcome. Doubtless it was in deference to this historical fact that the present commission hesitated to imperil its work by similar opposition.

The centesimal division of the quadrant also failed of acceptance at that time, although very complete tables of angular functions and their logarithms were computed. These tables, which are still in manuscript, represent a vast amount of accurate work, and have frequently been consulted to assist in correcting errors and comparing results by computers of other nations; and, if the proposed change is attempted in France, it is not improbable that the "great French manuscript tables," as they are called, may be published.

The prospects of the general introduction of the proposed changes are, we think, decidedly remote, especially in view of the strong opposition of late developed in this country against the metric system itself. If the 24-hour division is retained, the general public will pay but little attento the subdivisions of the hour. It will be found that there are two opposing elements in human practice in subdivision; the decimal, based upon the ten fingers, and the idea of continual bisection, which is almost as strong, and quite as natural. The two can never be entirely reconciled, and it is not impossible that in the far distant future we shall wonder why people ever retained either.

Incandescent Gas-Burners.

A COMMUNICATION to the Belgian Association of Gas Manufacturers by M. A. Bandsept, printed in the *Moniteur Industriel* for March 6, gives the results of attempts to improve the performance of incandescent gas-burners of the Welsbach type by producing a more intimate mixture of the air and gas before combustion. It is well known that such mixing greatly increases the efficiency of gas engines, and, theoretically, the more intense heat thus produced should increase the quantity of light from a burner depending upon the heating power for its illuminating effect.

The burner described by M. Bandsept is constructed so that the air and gas in entering, pass through a system of orifices forming a kind of atomizer, the proportion of gas and air being capable of adjustment experimentally, until the best effect is produced. The heat which may be thus produced is much more intense than that of the common Bunsen burner, readily fusing fine platinum wire, or iron or copper of several millimeters in thickness. When the gas-pressure is high, the combustion of the mixed air and gas is accompanied by a humming noise, due to the rapid succession of minute explosions; but this should not occur at the pressure used for ordinary lighting. Exact figures of the actual economy effected by this form of construction are yet lacking, but there can be little doubt that the higher temperature thus obtainable from a given quantity of gas should have a corresponding effect upon the illuminating power.

Electrical Industry in Russia.

RUSSIA appears to be carrying out her traditional policy of stimulating the growth of internal industry, by developing the arts depending upon electricity; an account of the extent to which progress in this direction has been made is given in the issue of *Die Elektricität* for March 13. In order to encourage the development of electrical industries, liberal concessions have been made to foreign corporations, both for lighting and for tramways, while the installations thus operated are being made the subject of earnest study by Russian technologists. As a consequence, although most of the machinery for the original plants was imported from England, Germany, and Switzerland, the building of electrical machinery is now beginning at home. There are now three builders of dynamos in St. Petersburg, one in Riga, and one in Wiborg, besides several establishments constructing accumulators and conductors. As yet the great bulk of the incandescent lamps and carbons are imported from Germany, but the Russian copper industry has already adopted the use of electrolytic reduction, both at the mines in the Caucasus and at Nijni-Novgorod. The German manufacturers are making strenuous efforts to control the Russian electrical trade, and to retard the development of local establishments, but the Russian policy of forcing home development is as strong to-day as in the days of Nicholas I, and will doubtless be pursued, regardless of questions of immediate economy or expediency.

Survey of Madagascar.

THE conquest of Madagascar by the French is bearing fruit, so far as geographical science is concerned, and the interior of the island, hitherto almost an unknown country, may now be mapped with a high degree of precision.

At the session of the Académie des Sciences, reported in *Le Génie Moderne* of April 1, Col. Bassot placed upon record a communication from M. R. Bourgeois, the chief of the geographical expedition to Madagascar, giving the principal results of the triangulation made of the island by Captain Peyronnel under his direction. The system extends from Majunga to the peak of Andriba, and includes stations on forty-nine mountain summits, this geodesic system having also been connected by route-surveys with positions astronomically determined. The work has been connected with the hydrographic surveys previously made, so that the coast, which has been well known for some time, is now in geodesic relation with the interior of the island.

The Rathausen Electric Station.

THE traveler in Switzerland will remember the rapid current of the Reuss as it flows from the Lake of Lucerne. This unfailing stream is now utilized in a most successful power station at Rathausen, about four miles down the river. An excellent account of this, one of the most recent water-power installations in Switzerland, is given in the *Elektrotechnische Zeitschrift* for March 4, with numerous illustrations.

The available fall is about 15 feet, and the supply about 900 cubic feet per second, so that there is nearly 1,500 h. p. to be obtained by damming the stream. The present works were begun in November, 1894, and completed in June, 1896. They include a dam, with canal leading the water to the works,—a building with machinery,—and a tail race canal, each canal being about three-quarters of a mile long.

The power plant consists at present of three turbines of 300 h. p. each at 60 revolutions, together with a small 6-h. p. turbine, used to operate the regulating gates, while there are pits for two more wheels of 300 h. p. each, which, when installed, will enable the entire power of the Reuss to be utilized.

The generators are directly connected to the turbine shafts, the armatures being stationary and the fields revolving. Owing to the moderate speed of rotation, the revolving fields are of large diameter, 3.6 meters giving a velocity of 2,227 feet per minute. The alternating current of 3,300 volts is transmitted to Emmenweid, Kriens, and Lucerne, the voltage being reduced by transformers at Eichhof to 1,500 volts; the maximum distance to which the current is transmitted is 9.2 kilometers.

The general equipment and arrangement of the station are most attractive. The plant, so far as the electric portion is concerned, was constructed by Brown, Boveri & Co., of Baden, the turbines being those of Th. Bell & Co., of Kriens.

In view of what is being done in this country, the scale of charges for electric power in Switzerland are of interest. The rate is made per day of twelve hours, from 6 A. M. to 7 P. M., on the following scale:

1 h. p.	$70.00 per year.
10 "	51.40 " "
50 "	36.00 " "
100 "	30.00 " "

At these prices an output of 983 h. p. is already taken, in motors ranging from 2.5 to 165 h. p., the greatest power taken by any one establishment being 200 h. p. by the Moos ironworks at Lucerne. The average does not exceed 25 h. p.

Special Subjects at the Paris Exposition.

LA REVUE TECHNIQUE for March 10 contains a curious list of special exhibits or projects which have been submitted to the management of the Paris Exposition of 1900. It will be seen that none of these offers so conspicuous a feature as either the Eiffel tower or the Ferris wheel, but at the same time there are a number of projects in the list which, if properly executed, would doubtless add greatly to the attractiveness of the display.

Among the subjects proposed we note:

A revolving building in which visitors, while resting, may behold successively all portions of the view;

An historical exhibition of chromo-photography, as well as of scenes in motion (cinematograph, etc.);

Several captive balloons;

Restorations of scenes in old France and of portions of old Paris;

A panorama-diorama, showing the tour of the world;

Reproductions of vessels,—a cruiser and an ocean steamer;

Traveling sidewalks;

A history of costume;

Tableaux of the progress of the nineteenth century;

Illuminated fountains;

Illumination effects on the river Seine;

A scientific congress, especially for the discussion of current problems, such as aerial navigation, photography in colors, vision at a distance, etc.;

Reproductions of mining operations.

Some of these are well-known adjuncts to modern expositions; others are more or less visionary, or of minor importance; no doubt a judicious selection will be made.

The Microphonograph.

BOTH the microphone and the phonograph are well-known instruments, and their combination has furnished an apparatus which has, for some purposes, most useful applications.

The microphonograph has been devised especially for physiological purposes by Professor Dussaud of Geneva, and a description of it is given in *Le Génie Moderne* for February 15.

The repeating microphonograph is intended for use in the treatment of deaf mutes, especially in teaching those in whom there exists the ability to hear very faint sounds, and those in whom the gradually-returning sense of hearing is to be developed. This apparatus consists of an ordinary phonograph with a microphone transmitter attached to the diaphragm, so that, by use of a telephone receiver, the utterances of the phonograph may be made audible to a person possessing only a very feeble sense of hearing. The strength of current required varies with the condition of the patient, and it has been found that in some cases thirty cells of battery were needed at first, while ultimately the same person could hear distinctly with but one cell. By using a judicious selection of cylinders, persons otherwise shut out almost entirely from audible communication with the world may thus be enabled to hear; and special communications may be spoken into the usual phonograph receiver, and the cylinder then used in the microphonograph.

The recording microphonograph is practically the reverse of the repeating instrument; it consists of a microphone attachment to an electrically-operated diaphragm, by which the feeblest sounds are recorded upon the phonograph cylinder. This form has proved especially useful in auscultation for pulmonary diseases and affections of the heart. Cylinders bearing the records of various cases may be preserved for use in connection with medical instruction, and heard simultaneously by a number of students.

The recording instrument may also be used most effectively in connection with psychological investigations. M. Dussaud also has the idea of using the instrument to open up, in the realm of sound, a field of investigation similar to that covered by the microscope and microphotography in the sphere of vision.

The Concentration of Sulphuric Acid.

A PAPER presented by M. Ch. Franche before the second international congress of applied chemistry upon the high concentration of mineral acids contains some points of interest which are here given from the full paper in *La Revue Technique*.

The increasing demand for sulphuric acid of a high degree of concentration, say 66° B., has developed the fact that the resistance of platinum to the action of such acid is not so great as has been generally thought. According to the investigations of Scheurer-Kestner, each ton of acid concentrated to 99.5 per cent. dissolves 9 grams of platinum. Various methods have been proposed to reduce this loss, the reduction of the exposed surface being the principle of several plans. The increasing cost of platinum stills, however, renders it desirable to do away with this loss altogether, and this has been attempted by plating the still with gold. Gold has ten times as great resistance to the boiling acid as platinum, but there has been much difficulty in obtaining a perfect adherence of the film. The best results have been obtained by Heraeus, of Berlin, who unites two pieces of gold and platinum at the fusing-point of gold, and then rolls the compound piece into sheets. It is claimed that the additional cost of the gold is saved in two years of use.

The apparatus of Faure and Kessler is intended to economize by increasing rapidity of evaporation. This is accomplished by the ingenious plan of passing through the still, above the acid, the hot dry gases from the furnace. By thus absorbing the vapor of water as rapidly as it rises from the acid, it is found possible to attain a concentration of 66° B. without raising the temperature above 170° to 200° C., while the boiling-point is 328° C. at atmospheric pressure. The fuel used is coke, and the apparatus is said to operate very satisfactorily and economically.

A New Method for Extracting Iodine.

THE present method of extracting iodine from the ashes of sea-weed by treating the kelp with sulphuric acid and peroxid of manganese and distilling the iodine out by heat is well known, but possesses disadvantages, which it is proposed to remove by a new process described in *La Revue Technique* (Feb. 10) by M. Alfred Boudon.

Instead of calcining the sea-weed, the new process treats it in the wet raw state, just as it comes from the water, thus retaining all the valuable fertilizing properties of the organic portion of the sea-weed in the residue. The delicate operation of volatilization and condensation is also avoided.

The principles involved in the new process are as follows: 1. If the raw sea-weed is treated with sea-water which has been rendered alkaline and deprived of its magnesia by the addition of the proper quantity of caustic lime, practically all of the iodine present will pass into solution.

2. From this solution the dissolved iodine may be entirely recovered by chemical operations conducted at ordinary temperatures.

3. The wet residue of sea-weed contains all its organic matter unaltered, as well as a good proportion of potash, and forms a very rich fertilizer.

Briefly, the details of the new process are as follows. The wet sea-weed is immersed for about twelve hours in sea-water containing eight kilograms of caustic lime to the cubic meter of water, this quantity being sufficient for half a ton of sea-weed. By this operation alone about sixty-five per cent. of the iodine is dissolved, and, by two successive infusions of six hours' duration, more than ninety per cent. of the iodine is abstracted. The mucilaginous matter in the solution is then precipitated by the addition of ferrous sulphate or caustic lime, and the clear liquid containing the iodine may be decanted off. After this has been neutralized by the addition of sulphuric acid, nitric acid is added, and the iodine is then dissolved in petroleum.

The practical operation of the process has been very satisfactory. From a ton of sea-weed containing 1.040 kilograms of iodine, 953 grams were extracted by the new method, or nearly 92 per cent. The residue of sea-weed after desiccation showed more than 50 per cent. of organic matter, 10 per cent. of potash, and 3.7 per cent. of nitrogen, forming an excellent fertilizer.

A French Trolley Road.

TROLLEY roads are yet somewhat of a novelty in France, and *La Revue Technique* gives much space to an account of the opening of the electric road at Chalons-sur-Marne.

The road, which at present operates only six cars, was opened in the presence of a great concourse by the prefect of the department and the mayor of the city, with much display of rhetorical fireworks and patriotic bunting, but is here noticed only because it shows that the overhead trolley is gaining a hold in France. Plans are being made for numerous overhead trolley lines in various cities of France, and, as we have already indicated in these columns, efforts are being made to obtain entrance for the overhead wire into Paris, in view of the necessities of transportation for the coming exposition.

An Improved Electric Furnace.

THE electric furnace has generally been used for the fusion of refractory substances on a commercial scale, but the *Elektrochemische Zeitschrift* for January illustrates a neat form intended for the distillation of metals, such as gold, silver, and copper, in the laboratory. The furnace, or, rather, crucible, is arranged to use a current of from 100 to 150 amperes between two carbon electrodes in a small chamber lined with carbon, and connections are provided so that any desired gases may be admitted, or vaporized metals discharged into suitable condensing vessels. The whole apparatus is fully described and illustrated, and its design is one which might readily be made available for many valuable investigations.

THE ENGINEERING INDEX.

A DESCRIPTIVE INDEX TO THE LEADING ARTICLES PUBLISHED CURRENTLY IN THE AMERICAN, BRITISH AND CONTINENTAL ENGINEERING JOURNALS.

INTRODUCTORY

This Index is issued separately from the Magazine printed on one side of the paper only, and is supplied to subscribers to the ENGINEERING MAGAZINE at a nominal charge of fifty cents a year to cover cost. In this form it meets the exact requirements of those who desire to clip the items for card-index purposes.

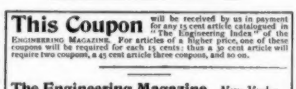
We hold ourselves ready to supply—usually by return mail—the full text of every article indexed, and our charge in each case is regulated closely by the cost of a single copy of the journal from which the article is taken. The price of each article is given just after the number. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

Serial publications are indexed on the appearance of the first installment.

The titles and addresses of the journals regularly reviewed are given in full below, but only abbreviated titles are used in the Index. Other abbreviations employed are: Ill=Illustrated; W=Words; Anon=Anonymous.

To avoid the inconvenience of small remittances, and to cheapen the cost of articles to those who order frequently, we sell the coupons which are represented here in miniature.

The price of these coupons is 15c. each, or fifteen for $2, forty or $5, and one hundred for $12.


This Coupon will be received by us in payment for any 15 cent article catalogued in "The Engineering Index" of the ENGINEERING MAGAZINE. For articles of a higher price, one of these coupons will be required for each 15 cents; thus a 30 cent article will require two coupons, a 45 cent article three coupons, and so on.
The Engineering Magazine, New York:
Please send Article No. _____ to the following address:
Facsimile Not Good

With a supply of these coupons on hand no letter writing is required. Simply fill in the number, and your address. A stamped envelope does the rest.

This system is strongly commended to our readers. The coupons need only a trial to demonstrate their convenience.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

Age of Steel, The *w.* $3. St. Louis.
American Architect, The *w.* $6. Boston.
American Electrician. *m.* $1. New York.
Am. Engineer and Railroad Journal. *m.* $2. N.Y.
American Gas Light Journal. *w.* $3. New York.
American Geologist. *m.* $3.50. Minneapolis.
American Journal of Science. *m.* $6. New Haven.
American Journal of Sociology. *b-m.* $2 Chicago.
American Machinist. *w.* $3. New York.
American Magazine of Civics. *m.* $3. New York.
Am. Manufacturer and Iron World. *w.* $4. Pittsburg.
American Shipbuilder. *w.* $2. New York.
Am. Soc. of Irrigation Engineers. *qr.* $4. Denver.
Am. Soc. of Mechanical Engineers. *m.* New York.
Annals of Am. Academy of Political and Social Science. *b-m.* $6. Philadelphia.
Annales des Ponts et Chaussées. *m.* 31 francs. Paris.
Architect, The. *w.* 26*s.* London.
Architectural Record. *q.* $1. New York.
Architectural Review. *s-q.* $5. Boston.
Architecture and Building. *w.* $4 New York.
Architektonische Rundschau. *m.* 18 marks. Stuttgart.
Arena, The *m.* $5. Boston.
Atlantic Monthly. *m.* $4. New York.
Australian Mining Standard. *w.* 30*s.* Sydney.
Baker's Railway Magazine. *m.* $2. N. Y.
Bankers' Magazine. *m* $5. New York.
Bankers' Magazine. *m.* 18*s.* London.
Bankers' Magazine of Australia. *m.* $3. Melbourne.
Berg- und Hüttenmännische Zeitung. *w.* 26 marks. Berlin.
Board of Trade Journal. *m.* 6*s.* London.
Boston Journal of Commerce. *w.* $3. Boston.
Bradstreet's. *w.* $5. New York.
Brick Builder, The *m.* $2.50. Boston.
British Architect, The. *w.* 23*s.* 8*d.* London.
Builder, The. *w.* 26*s.* London.
Bulletin Am. Iron and Steel Asso. *w.* $4. Phila
Bulletin of the Univ. of Wisconsin. Madison.
California Architect. *m.* $3. San Francisco
Canadian Architect. *m.* $2. Toronto.
Canadian Electrical News. *m.* $1. Toronto.
Canadian Engineer. *m.* $1. Montreal.
Canadian Mining Review. *m.* $3. Ottawa.
Century Magazine. *m.* $4. New York.
Chautauquan, The *m.* $2. Meadville, Pa.
Colliery Engineer. *m.* $2. Scranton, Pa.
Colliery Guardian. *w.* 27*s.* 6*d.* London.
Compressed Air. *m.* $1. New York.
Contemporary Review. *m.* $4.50. London
Deutsche Bauzeitung. *b-w.* 15 marks. Berlin.
Dingler's Polytechnisches Journal. *w.* 43.60 marks. Stuttgart.
Domestic Engineering. *m.* $2. Chicago
Electrical Engineer. *w.* 19*s.* 6*d.* London.
Electrical Engineer. *w.* $3. New York
Electrical Engineering. *m.* $1. Chicago.
Electrical Review. *w.* 21*s.* 8*d.* London.
Electrical Review. *w.* $3. New York.
Electrical World. *w.* $3. New York.
Electrician. *w.* 24*s.* London.
Electricity. *w.* $2.50. New York.
Electricity. *w.* 7*s.* 6*d.* London.
Elektrochemische Rundschau. *b-m.* 9.50 marks. Frankfurt.
Elektrotechnisches Zeitschrift. *m.* 18.40 marks. Berlin.
Elektrotechnisches Echo. *w.* 12 marks. Magdeburg.
Elektrotechniker. *b-m.* 12 marks. Vienna.
Elektrotechnischer Anzeiger. *s-w.* 10 marks. Berlin.
Elektrotechnische Zeitschrift. *w.* 25 marks. Berlin.
Engineer, The. *s-m.* $2. New York.
Engineer, The. *w.* 36*s.* London.

Engineers' Gazette. *m.* 8*s.* London.
Engineering. *w.* 36*s.* London.
Engineering Assns. of the South. Nashville.
Engineering and Mining Journal. *w.* $5. N. Y.
Engineering Magazine. *m.* $3. New York.
Engineering-Mechanics. *m.* $2. Phila.
Engineering News. *w.* $5. New York.
Engineering Record. *w.* $5. New York.
Eng. Soc. of the School of Prac. Sci. Toronto.
Eng. Soc. of Western Penn'a. *m.* $7. Pittsburg.
Fire and Water. *w.* $3. New York.
Forester, The. *bi-m.* 50 cts. May's Landing, N.J.
Fortnightly Review. *m.* $4.50. London.
Forum, The. *m.* $3. New York.
Foundry, The. *m.* $1. Detroit.
Garden and Forest. *w.* $4. New York.
Gas Engineers' Mag. *m.* 6*s.* 6*d.* Birmingham.
Gas World, The. *w.* 13*s.* London.
Gesundheits-Ingenieur. *s-m.* 16 marks. München.
Glasers Annalen für Gewerbe und Bauwesen. *s-m.* 20 marks. Berlin.
Gunton's Magazine. *m.* $2. New York.
Harper's Weekly. *w.* $4. New York.
Heating and Ventilation. *m.* $1. New York.
Ill. Carpenter and Builder. *w.* 8*s.* 8*d.* London.
India Rubber World. *m.* $3. New York.
Indian and Eastern Engineer. *w.* 20 Rs. Calcutta.
Indian Engineering. *w.* 18 Rs. Calcutta.
Industries and Iron. *w.* £1. London.
Inland Architect. *m.* $5. Chicago.
Iron Age, The. *w.* $4.50. New York.
Iron and Coal Trade Review. *w.* 30*s.* 4*d.* London
Iron & Steel Trades' Journal. *w.* 25*s.* London
Iron Trade Review. *w.* $3. Cleveland.
Jour. Am. Soc. Naval Engineers. *qr.* $5. Wash.
Journal Assoc. Eng. Society. *m.* $3. St. Louis.
Journal Franklin Institute. *m.* $5. Phila.
Journal of Gas Lighting. *w.* London.
Jour. N. E. Waterw. Assoc. *q.* $2. New London.
Journal Political Economy. *q.* $3. Chicago.
Journal Royal Inst. of Brit. Arch. *s-q.* 6*s.* London.
Journal of the Society of Arts. *w.* London.
Journal of the Western Society of Engineers. *b-m* $2. Chicago.
Kansas University Quarterly. *qr.* $2. Lawrence Kan.
La Nature. *w.* 24.50 francs. Paris.
La Révue Technique. *b-m.* 28 francs. Paris.
L'Eclairage Electrique. 60 fr. Paris.
Le Génie Civil. *w.* 45 fr. Paris.
L'Electricien. *w.* 25 fr. Paris.
Le Moniteur des Architectes. *m.* 33 francs. Paris.
Le Moniteur Industriel. *w.* 40 francs. Paris.
Locomotive Engineering. *m.* $2. New York.
Machinery *m.* $1. New York.
Machinery. *m.* 9*s.* London.
Manufacturer's Record. *w.* $4. Baltimore.
Marine Engineer. *m.* 7*s.* 6*d.* London.
Marine Engineering. *m.* $2. New York.
Master Steam Fitter. *m.* $1. Chicago.
Mechanical World. *w.* 8*s.* 8*d.* London
McClure's Magazine. *m* $1. New York.
Metal Worker. *w.* $2. New York.
Mining and Sci. Press. *w.* $3. San Francisco
Mining Industry and Review. *w.* $2. Denver.
Mining Journal, The. *w.* £1. 8*s.* London.
Mittheilungen des Vereines für die Förderung des Local- und Strassenbahnwesens. *m.* fl. 12. Vienna.
Monatsschrift des Württ. Vereines für Baukunde. 10 parts yearly. 3 marks. Stuttgart.
Municipal Engineering. *m.* $2. Indianapolis.
National Builder. *m.* $3. Chicago.
Nature. *w.* $7. London.
New Science Review, The. *qr.* $2. New York.
Nineteenth Century. *m.* $4.50. London.
North American Review. *m.* $5. New York.
Oesterreichische Monatsschrift für den Oeffentlichen Baudienst. *m.* 14 marks. Vienna.
Oesterr. Zeitschrift für Berg- & Hüttenwesen. *w.* 24 marks. Vienna.
Physical Review, The. *b-m.* $3. New York.
Plumber and Decorator. *m.* 6*s.* 6*d.* London.
Popular Science Monthly. *m.* $5. New York.
Power. *m.* $1. New York.
Practical Engineer. *w.* 10*s.* London.
Proceedings Engineer's Club. *q.* $2. Phila.
Proceedings of Central Railway Club.
Pro. of Purdue Soc. of Civ. Engs. *yr.* 50 cts. La Fayette, Ind.
Progressive Age. *s-m.* $3. New York.
Railroad Car Journal. *m.* $1. New York.
Railroad Gazette. *w.* $4.20. New York.
Railway Age. *w.* $4. Chicago.
Railway Magazine. *m.* $2. New York.
Railway Master Mechanic *m.* $1. Chicago.
Railway Press, The. *m.* 7*s.* London.
Railway Review. *w.* $4. Chicago.
Railway World. *m.* 5*s.* London.
Review of Reviews. *m.* $2.50. New York.
Safety Valve. *m.* $1. New York.
Sanitarian. *m.* $4. Brooklyn.
Sanitary Plumber. *s-m.* $2. New York.
Sanitary Record. *m.* 10*s.* London.
School of Mines Quarterly. $2. New York.
Schweitzerisches Bauwesen. *w.* 20 marks. Zurich.
Science. *w.* $5. Lancaster, Pa.
Scientific American. *w.* $3. New York.
Scientific Am. Supplement. *w.* $5. New York.
Scientific Machinist. *s-m.* $1.50. Cleveland, O.
Scribner's Magazine. *m.* $3. New York.
Seaboard. *w.* $2. New York.
Sibley Journal of Eng. *m.* $2. Ithaca, N. Y.
Southern Architect. *m.* $2. Atlanta.
Stahl und Eisen. *s-m.* 20 marks. Dusseldorf.
Stationary Engineer. *m.* $1. Chicago.
Steamship. *m.* Leith, Scotland.
Stevens' Indicator. *qr.* $1.50. Hoboken.
Stone. *m.* $2. Chicago.
Street Railway Journal. *m.* $4. New York.
Street Railway Review. *m.* $2. Chicago.
Technology Quarterly. $3. Boston.
Tradesman. *s-m.* $2. Chattanooga, Tenn
Trans. Assn. Civil Engs. of Cornell Univ. Ithaca.
Trans. Am. Ins. Electrical Eng. *m.* $5. N. Y.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Civil Engineers. *m.* $10. New York
Transport. *w.* £1. 5*s.* London.
Western Electrician. *w.* $3. Chicago.
Western Railway Club, Pro. Chicago.
Wiener Bauindustrie Zeitung. *w.* 27 marks. Vienna.
Wisconsin Engineer. *qr.* $1.50. Madison, Wis.
Yale Scientific Monthly, The. *m.* $2.50 New Haven.
Zeitschrift für Lokomotivführer. *m.* 5 marks. Hannover.
Zeitschrift für Maschinenbau & Schlosserei, Berlin.
Zeitschrift des Oesterreichischen Ingenieur und Architekten Vereines *w.* 33 marks. Vienna.
Zeitschrift des Vereines Deutscher Ingenieure. *w.* 32 marks. Berlin.
Zeitschrift für Elektrochemie. *s-m.* 16 marks. Halle, a. S.
Zeitschrift für Elektrotechnik. *s-m.* 16 marks. Halle a. S.
Zeitschrift für Instrumentenkunde. *m.* 20 marks. Berlin.

ARCHITECTURE AND BUILDING.

CONSTRUCTION AND DESIGN.

APARTMENT-HOUSE.

The Center Court Apartment House. Description, with plans, of a five-story and basement brick building recently built on 28th St., New York. 1100 w. Eng Rec—April 3, 1897. No. 12088. 15 cts.

AUSTRIA.

Austrian Architecture. (Wiener Bauten-Album) Plates and descriptive text of buildings in Graz, Gemunden, and Vienna. 3500 w. and 10 plates. Wiener Bauindustrie Zeitung—Feb. 25, 1897. No. 12493. 60 cts.

CHURCH.

The Church of Brou-en-Bresse. Historical account with description. 2000 w. Builder—April 10, 1897. No. 12261. 30 cts.

The Church of St. Bartholomew the Great, Smithfield, London, E. C. The history and restoration of a church of mediæval beauty. 1800 w. Am Arch—April 24, 1897. No. 12349. 15 cts.

COUNTRY HOMES.

The Architecture of American Country Homes. H. Neill Wilson. The development of rural architecture as shown in the Berkshire hills. Ill. 2300 w. Eng Mag—May, 1897. No. 12586. 30 cts.

DWELLINGS.

The Dwelling Problem in Great Cities, and its Solution. (Die Wohnungsnoth in Grossen Städten und deren Bekämpfung). Discusses the problem of providing for the rapidly increasing population of great cities, with views of recently erected apartment houses. The subject is considered entirely from a Continental standpoint. 7500 w. Oesterr Monatschr. f. d. Oeffent. Baudienst—March, 1897. No. 12421. 30 cts.

EXPOSITION Buildings.

The Exposition of 1900. (L'Exposition de 1900.) Plans and elevation of the new palace of the Champs Elysées. 3500 w. Two articles. Le Génie Moderne—March 15 & April 1, 1897. No. 12440. 60 cts.

FIRE-PROOF Floors.

Tests of Fire-Proof Floor Constructions. Report of tests made on various forms of construction, with results. 1600 w. Eng News—April 22, 1897. No. 12314. 15 cts.

FLOORS.

Computations for Monier Floors. (Ueber die Berechnung der Monier Platten.) A mathematical discussion of the computations for cement floors with the Monier System of wire reinforcement. 5000 w. Zeitschr d. Oesterr. Ing. u. Arch. Vereines—March 26, 1897. No. 12417. 30 cts.

FOUNDATIONS.

Apparatus for determining the Supporting Power of Soils. (Ueber ein Apparat zur Ermittelung der Natürlichen Tragfähigkeit des Baugrundes.) Describes improved methods of measuring the supporting power of the ground and investigates the laws by which it is governed. 4500 w. and 1 plate. Oesterr Monatschr. f. d. Oeffent. Baudienst—March, 1897. No. 12422. 30 cts.

Substructure of the Commercial Cable Building. Conditions and descriptions of caissons, plans, sectional elevations, underpinning adjacent foundation by hydraulic and pneumatic process; working platform and traveling derrick; sinking caissons and profile of stratification. Ill. 1700 w. Eng Rec—April 17, 1897. Serial. 1st part. No. 12220. 15 cts.

GOTHIC Architecture.

Gothic Architecture in Northern Italy. A. C. Hutchinson. Read before the Province of Quebec Asso of Archs. Reviews the architectural environment of the Italian people of the 13th & 14th centuries, and describes features that mark the building of this period. 3000 w. Can Arch—April, 1897. No. 12270. 30 cts.

GOVERNMENT Buildings.

The New Government Offices Scheme. H. H. Statham. Abstract of a paper, with discussion, presented at meeting of the Roy. Inst. of Brit. Archs. The treatment of the buildings from an architectural point of view, and the alignment of streets are discussed. 5500 w. Builder—April 17, 1897. No. 12340. 30 cts.

LAUNDRY.

The arrangement of Public Laundrys. (Industrielle Wäschereien.) With plans of the arrangement of machinery, including hospital service. 3500 w. Gesudheits Ingenieur—Jan. 31, 1897. No. 12450. 30 cts.

STEEL Structures.

Some Recent Examples of Steel Structural Work Adopted in Various Types of Buildings. Andrew S. Biggart. Read before the Inst. of Engs. and Shipbuilders, Scotland. Deals principally with some works carried out by the author's firm, but only in a general way. Ill. 3300 w. Ir & St. Trds Jour—March 27, 1897. No. 12056. 30 cts.

STEEL Construction.

Steel Work in a Modern Power House. Harry R. Jones. Illustrated description of the new electric power house of the Metropolitan Street R. R. Co., at Kansas City, Mo. A good example of modern steel power-house construction. 900 w. Eng News—April 8, 1897. No. 12136. 15 cts.

VIENNA.

Vienna Buildings (Wiener Bauten-Album) Plates and text descriptive of old and new buildings in Vienna. 1500 w. and 6 plates. Wiener Bauindustrie Zeitung—Jan. 28, 1897. No. 12492. 45 cts.

HEATING AND VENTILATION.

ELECTRIC Heating.

Electric Heating of Niagara Falls Power Station. Orrin E. Dunlap. Illustrated description. An interesting study on the subject of electric heating. 900 w. W Elec—April 10, 1897. No. 12132. 15 cts.

The Electric Heater. H. E. Stauffer. A general illustrated description of some of the more recent forms of heaters showing how they are applied and used. 3500 w. Sci Am Sup—April 24, 1897. No. 12292. 15 cts.

FITTINGS.

Screwed Fittings for High Pressure. Hugh J. Barron. Advocates the manufacture of wrought iron or wrought or cast steel or malleable iron fittings for screwed work for heavy pressures and for all large pipe work except that used for very low pressures. 900 w. Dom Engng—April, 1897. No. 12367. 30 cts.

FURNACE Heating.

Furnace Heating. The causes why they sometimes fail to heat. Discusses location of registers, location of furnace, sizes of hot air pipes and defects in buildings. 1200 w. Dom Engng—April, 1897. No. 12364. 30 cts.

HEATING.

Heating a Mill from an Economizer. Describes the system, showing the method diagrammatically. 800 w. Eng Rec—April 3, 1897. No. 12089. 15 cts.

Heating Places of Worship and Other Buildings Not Having Regular Daily Use. Frederick Dye. Calls attention to heating by low-pressure steam, which the writer thinks especially adapted to the purpose, fulfilling every special requirement, and possessing no disadvantages. 1900 w. Dom Engng—April, 1897. No. 12369. 30 cts.

Prehistoric and Modern Heating Appliances. Robert Grimshaw. Part first traces the progress of heating appliances from the earliest times, giving illustrations of advancing stages. 1800 w. Dom Engng—April, 1897. No. 12366. 30 cts.

HUMIDITY.

The Drosophore, for the Humidification of the Air. (Humidification de l'Air; Le Drosophore.) An apparatus for maintaining the proper degree of humidity in spinning and weaving mills by a combination of atomizers and air currents. 1500 w. La Revue Technique—March 25, 1897. No. 12427. 30 cts.

OFFICE Buildings.

Heating and Ventilating Large Office Buildings. Thomas Barwick. Discusses the different systems employed giving the writer's preference, and reasons. 2000 w. Heat & Ven—April 15, 1897. No. 12242. 15 cts.

Heating of the Bowling Green Office Building, New York City. Illustrated description of a large plant requiring 23,500 lineal feet, or 4½ miles of steam and return piping. 1500 w. Heat & Ven—April 15, 1897. No. 12241. 15 cts.

RADIATING Surface.

The Utilization of Radiating Surface. A. J. Kingsley. A study of the subject with the view of finding means of discriminating as to the relative value of the different styles of radiators on the market. 1700 w. San Plumb—April 15, 1897. No. 12273. 15 cts.

SCHOOL Buildings.

Ventilation of School Buildings. S. H. Woodbridge. Considers the relation of air to vital energy, cost of air supplied, and some simple methods of ventilating. Ill. 2300 w. San Plumb—April 15, 1897. No. 12275. 15 cts.

Heating of a New Haven School. Illustrated description of the heating and ventilating plant of the Norton school building. 1300 w. Eng Rec—April 17, 1897. No. 12221. 15 cts.

STEAM Heating.

Experiments upon High and Low Pressure Steam Heating. (Beobachtungen an einer Centralheizung mit Niederdruck Abdampf und Dampf von 2 Atm. Ueberdruck.) With a total heating surface of 1405 square metres, steam at 30 pounds gave 740 calories per square metre per hour, and steam at 3.5 lbs., 460 calories. Full details of the test are given. 4500 w. Oesterr. Monatschr. f. d. Oeffent. Baudienst—March, 1897. No. 12423. 30 cts.

Defective Drainage in Steam Pipes and Its Results. Calls attention to facts which show the intense strain to which pipes are subjected where water is allowed to rest in them. 1,000 w. San Plumb—April 15, 1897. No. 12274. 15 cts.

High Pressure Heating. Frederick Dye, in Building World, London. Discusses this method of warming buildings, its advantages and disadvantages. 1800 w. Dom Eng—April, 1897. Serial. 1st part. No. 12365. 30 cts.

VENTILATION.

See same title under Railroad Affairs. Miscellany.

WARMING.

A Study in Warming-Furnaces. (Eine Ofenstudie.) An account of experiments made in Norway by Dr. Henrichsen, upon the value of different fuels for house warming. 3500 w. Gesundheits-Ingenieur—Feb. 28, 1897. No. 12443. 30 cts.

Heating by Warm Air. (Ueber Luftheizung.) Especially discussing in direct systems of steam and hot water heating, and opposing the use of direct radiators in rooms. 5000 w. Gesundheits-Ingenieur—March 15, 1897. No. 12446. 30 cts.

LANDSCAPE GARDENING.

GARDENING.

A Suburban Country Place. M. G. Van Renssellaer. Illustrated description of the beauty of Brookline, near Boston, brought about by the art of the landscape gardener. 6500 w. Cent Mag—May, 1897. No. 12517. 45 cts.

Three Mediterranean Gardens. Walter Harrington Kilham. A discussion of the style of gardening which prevails in the south of Italy and Spain, illustrating their peculiarities and suggesting their possibilities of imitation. 1300 w. Am Arch—April 10, 1897. Serial. 1st part. No. 12173. 15 cts.

LANDSCAPE ART.

The Field of Landscape-Art. Editorial talk on the requirements and outlook in this field. 900 w. Gar and For—April 28, 1897. No. 12375. 15 cts.

PARK Systems.

The Park Systems of Minneapolis and St. Paul, Minnesota. Mary C. Robbins. An account of the scheme outlined by the landscape architect, W. S. Cleveland, of the important beginning made at Minneapolis, and the neglect of St. Paul. 1800 w. Gar and For—April 28, 1897. No 12376. 15 cts.

PLUMBING AND GASFITTING.

APARTMENTS.

Plumbing in Center Court Apartments. Decription, with illustrations, of the plumbing of a five story brick building on West 28th St.,

New York. 1100 w. Eng Rec--April 10, 1897. No. 12179. 15 cts.

DRAINAGE.

Modern Standards for House Drainage. Gives the series of by-laws drafted by the London County Council, which it is proposed to enact into law, which will give a uniform drainage practice to the entire metropolitan area. 2000 w. Dom Engng—April, 1897. Serial. 1st part. No. 12363. 30 cts.

PLUMBING.

Plumbing in the Bank of Commerce Building. Part first contains a general description, requirements of materials and workmanship, system of water distribution and drainage, conventional diagrams of arrangement of water service and typical riser lines. 2000 w. Eng Rec--April 24, 1897. Serial. 1st part. No. 12339. 15 cts.

SANITATION.

Sanitary Appliances. W. M. Watson. Objections to sanitary rules in force in Toronto, with reasons. Ill. 2700 w. Can Eng—April, 1897. No. 12188. 15 cts.

SOIL PIPES.

English Soil Pipes, and How Plumbers Run Them. A few details of soil pipe work, with illustrations. 1000 w. Dom Engng—April, 1897. No. 12362. 30 cts.

MISCELLANY.

ARCHITECTURE.

Eighteenth Century Work. J. A. Gotch. Read at meeting of the Architectural Assn., London. Points out the advantages and disadvantages of the styles. An interesting paper. Followed by discussion. 9000 w. Builder—March 27, 1897. No. 12059. 30 cts.

HANDICRAFTS.

Architecture in Relation to the Handicrafts. T. G. Jackson. Read at meeting of the British Arch. Assn. The authority of noted writers on architecture is given, the modern system discussed, and the changes in conditions which must be met, with the writer's suggestions. 5500 w. Arch, Lond—April 9, 1897. No. 12245. 30 cts.

INTERIORS.

Modern House Interiors. T. Butler Wilson. Read before the Leeds and Yorkshire Arch. Soc. Extract. Arguing that the whole decorative scheme of the interior should be the business of the architect. 2000 w. Arch, Lond—April 9, 1897. No. 12244. 30 cts.

LEAD.

Lead Work. W. R. Lethaby. Read before the Soc. of Arts. Abstract. Discusses lead cisterns, fountains and conduits; lead roofs, spires, domes, and belfrys, and ornamental lead work. 3300 w. Brit Arch—April 16, 1897. No. 12341. 30 cts.

LEADED GLASS.

Stained and Leaded Glass Work. Richard Matthews. History of the manufacture; part first is confined to ancient work. Illustration. 1700 w. Ill Car & Build—April 16, 1897. Serial. 1st part. No. 12319. 30 cts.

LONDON.

The "Uglification" of London. Editorial criticism of various works which have been carried out in London and its suburbs. 2500 w. Builder—March 27, 1897. No. 12058. 30 cts.

MEDIAEVAL Architecture.

Heraldry in English Mediæval Architecture. W. H. St. John Hope. The paper is confined to the period from 1216 to 1547, showing how far heraldry and architecture were associated. Illustrated descriptions of early applications are given. Full paper, with discussion. 9800 w. Jour Roy Inst of Brit Arch—March 18, 1897. No. 12324. 75 cts.

MONUMENT.

The Imperial Monument in Berlin. (Das Kaiserdenkmal auf der Schloss Freiheit zu Berlin) Fully illustrated account of the monument to the memory of the Emperor William I, recently unveiled in Berlin. Two articles, 1 plate. 4500 w. Deutsche Bauzeitung—March 20, 27, 1897. No. 12488. 30 cts.

The Imperial Monument on the Kyffhaüser. (Das Kaiser-Denkmal auf dem Kyffhaüser). With illustrations from photographs, of the fine Barbarossa monument. Two articles & 1 plate. 2500 w. Deutsche Bauzeitung—Feb. 27 & March 6, 1897. No. 12487. 30 cts.

The Leipzig National Monument. (Das National-Denkmal bei Leipzig.) Description with illustrations, of the designs submitted in the competition for the monument to be erected upon the battle field of Leipzig. Two articles—2500 w. 1 plate. Deutsche Bauzeitung—Jan. 16,23, 1897. No. 12486. 30 cts.

PARTHENON.

The Doom of the Parthenon. J. R. S. Sterrett, in the "Evening Post." Describes the state of general dilapidation, and predicts an early collapse. 1000 w. Arch & Build—April 10, 1897. No. 12145. 15 cts.

PUEBLO.

Pueblo Architecture. Cosmos Mindeleff. Illustrated description of aboriginal American house structures. 2000 w. Am Arch—April 17, 1897. Serial. 1st part. No. 12237. 15 cts.

PYRAMIDS.

Pyramids and their Relation to Monumental and Sacred Architecture. Cyrus K. Porter. Considers the monumental pyramids of Egypt, their adaptation to the purpose of sacred architecture in Mexico and Central America, and the pyramidal shaped temples of India. An interesting, illustrated article. 5500 w. Stone—April, 1897. No. 12317. 30 cts.

ROOFING.

Roofing Slate in Ireland. Information extracted from recent reports of U. S. Consuls at Belfast and Dublin. 2500 w. Stone—April, 1897. No. 12318. 30 cts.

WALES.

Art in Wales. T. E. Ellis. An address delivered before the Cymmrodorion Society. Contains interesting information of Welsh architecture and arts. 7300 w. Arch, Lond—April 2, 1897. No. 12189. 30 cts.

WOODS.

Summary of Mechanical Tests on Thirty-two Species of American Woods. Statement of results of the timber investigations carried on by the Div. of Forestry. The object of these investigations is to increase the general knowledge of the properties and behavior of wood and to discover facts that will enable the consumer to judge of the comparative value. 4000 w. U. S. Dept of Agri—Circ. No. 15. No. 12215. 45 cts.

CIVIL ENGINEERING.

BRIDGES.

BRIDGES.
See same title under Railroad Affairs, Maintenance of Way.

FOUNDATIONS.
The Distribution of Pressure in Stepped Foundations. (Ueber die Druckvertheilung in Absatzweise Verbreiterten Mauerwerksfundamenten.) An examination of the manner in which the pressure of a pier is transmitted to the extended portion of the foundation. 2500 w. Zeitschr d. Oesterr. Ing. u. Arch. Vereines—March 26, 1897. No. 12418. 30 cts.

LIFT BRIDGE.
The New Huron Street Lift-Bridge, Milwaukee, Wis. M. G. Schinke. Detailed description with illustrations. 1800 w. Eng News—April 22, 1897. No. 12313. 15 cts.

PLATE GIRDER.
The Transportation and Erection of a Plate Girder Highway Bridge. Description of the transportation of the material and the erection of a plate girder bridge, built by the Wabash Bridge & Iron Works. An interesting study of simple and effective methods of overcoming difficulties. Ill. 1800 w. Eng News—April 15, 1897. No. 12204. 15 cts.

ROCK ISLAND Bridge.
Erection of the Draw Span of the New Rock Island Bridge. Ralph Modjeski. An interesting illustrated description going into details, and followed by short discussion. 9200 w. Jour W Soc of Engs—April, 1897. No. 12398. 45 cts.

STEEL.
See same title under Mining and Metallurgy. Iron and Steel.

TRUSSES.
Trusses with Suspended Horizontal Thrust. (Bogenträger mit Aufgehobenem Horizontalschub.) A design for arched trusses, whereby the horizontal thrust may be converted into a vertical pull sustained by a tension member anchored in the pier. 2000 w. Zeitsch d Vereines Deutscher Ingenieure—March 20, 1897 No. 12407. 30 cts.

CANALS, RIVERS AND HARBORS.

CANAL.
A Black Sea and Baltic Canal. Description, with map, of the route proposed, work, cost, &c. 800 w. Eng, Lond—April 9, 1897. No. 12238. 30 cts.

Canadian Waterways and the Canadian Tariff. A statement of two important announcements from Canada. First, the decision to begin the enlarging of the canal system connecting the great lakes and St. Lawrence; second, the decision to discriminate against the United States, in favor of Great Britain, in the new tariff bill. 900 w. Trans—April 2, 1897. No. 12158. 30 cts.

Canal Communication from the Midlands to the Sea. A brief review of the four main routes which are referred to as of prime importance to the Midlands, with other information. 3000 w. Eng, Lond—March 26, 1897. No. 12098. 30 cts.

EXCAVATING.
See same title under Mechanical Engineering, Miscellany.

FLOODS.
Fraser Valley Reclamation. R. E. Palmer. Describes the system of reclamation adopted, with plate showing a longitudinal section through the foundation. 3500 w. Can Soc of Civ Engs—April 8, 1897. Advance Proof. No. 12315. 45 cts.

The Mississippi Flood. Brief illustrated account of the recent flood and the damage done by it. 1700 w. Harper's Wk—April 17, 1897. No. 12194. 15 cts.

The Floods of the Mississippi River. William Starling. A paper prepared before the recent flood. Part first is an interesting illustrated description of the basin, and the influences causing the floods. 7700 w. Eng News—April 22, 1897. Serial. 1st part. No. 12309. 15 cts.

National Interest in the Mississippi. Discussion of the flood situation. 1200 w. Bradstreet's—April 17, 1897. No. 12218. 15 cts.

LOCK.
Deepening a Canal Lock. Brief description of special methods adopted in the modification of the existing locks of the Erie Canal so that they will conform to the increased draft of water secured in other parts of the canal. Ill. 600 w. Eng Rec—April 10, 1897. No. 12178. 15 cts.

NICARAGUA.
Nicaraguan Ports and the Nicaragua Canal. Discusses the necessity for and advantages of the canal and the ports where the greatest extension of trade may be expected. 1700 w. Bd of Trd Jour—April, 1897. No. 12392. 30 cts.

Surveying in Nicaragua. J. Francis Le Baron. Experiences in work on the interoceanic canal; location, climatic peculiarities, animal and insect pests. 3800 w. Eng Rec—April 24, 1897. No. 12337. 15 cts.

IRRIGATION.

CANAL Irrigation.
Canal Irrigation in Modern Mexico. C. P. MacKie. Descriptive of the Tlahualilo canal system and its construction. Ill. 3800 w. Eng Mag—May, 1897. No. 12580. 30 cts.

IRRIGATION Farm.
An Experimental Irrigation Farm at Bellary. Discussion of the proposed plan of experimental farms being opened to promote agricultural education in the Madras Presidency. 1500 w. Ind Engng—March 6, 1897. No. 12184. 45 cts.

MISCELLANY.

BEAMS.
See same title under Mechanical Engineering, Miscellany.

HIGHWAYS.

The Construction Methods of the Massachusetts Highway Commission. A description of the different classes of roads with some of the general principles. 3000 w. Eng Rec--April 3, 1897. No. 12087. 15 cts.

INSTITUTION of Civil Engineers.

A Change in the Requirements for Admission to the Institution of Civil Engineers. The age of admission raised, examination required &c. Commented upon editorially. 1400 w. Eng News--April 22, 1897. No. 12310. 15 cts.

INSTRUMENTS.

Early History of Instruments and the Art of Observing in Astronomy and Civil Engineering. Charles S. Howe. Briefly traces the history from the time of the gnomon and the astrolabe to that of the transit circle and the altazimuth, &c., closing with the beginning of modern instruments. 4000 w. Jour Assn of Engng Soc --March, 1897. No. 12513. 30 cts.

MONTANA.

Address before the Montana Society of Civil Engineers. John Herron. The retiring president gives a summary of the engineering progress in the state, with a statement of the needs of the society. 3800 w. Jour Assn of Engng Soc—March, 1897. No. 12511. 30 cts.

RATING.

Rating of Engineering Undertakings. P. Michael Faraday. Read at meeting of the Soc. of Engs. Discusses the methods by which these undertakings are assessed—with some details in the application to particular hereditaments. 3800 w. Arch, Lond--April 9, 1897. No. 12246. 30 cts.

TIMBER.

Preservation of Timber. John D. Isaacs. Descriptions of methods of timber preservation given in a paper which was published in a report by the state mineralogist of California. 2900 w. Ry Rev—April 24, 1897. No. 12373. 15 cts.

WAR Material.

The Transformations of Material of War. (Les Transformations du Matériel de Guerre.) An interesting article by Col. Fix, reviewing the past and probable future of applied engineering in modern warfare. 3500 w. La Revue Technique—March 25, 1897. No. 12429. 30 cts.

BETON.

The Computation of Béton Beams. (Zur Berechnung der Betonbalken.) Records of tests of beams of béton after different times of setting; surtaining the correctness of Navier's theory. 3500 w. Zeitscher. d. Oesterr. Ing. u. Arch. Vereines--March 12, 1897. No. 12413. 30 cts.

CEMENT.

Slag Cement (Le Ciment de Laitier). An account of the manufacture of slag cement at Vitry-le-Français, with data as to the precautions to be observed to insure success. 1000 w. Moniteur Industriel—Feb. 13, 1897. No. 12491. 30 cts.

ENGINEER.

The Status of the Engineer. George F. Swain. Considers the engineer's standing as compared with other professions, and his defects and their remedies. 3800 w. Jour Asso of Engng Soc—March, 1897. No. 12514. 30 cts.

GREAT Lakes.

The Control of the Levels of the Great Lakes. W. A. Jones. Showing that it is possible, by a system of dams at the outlets of the Great Lakes, to maintain their surfaces at a constant level, and thereby facilitate navigation and commerce. 2900 w. Eng Mag--May, 1897. No. 12583. 30 cts.

ECONOMICS AND INDUSTRY.

COMMERCE AND TRADE.

AGRICULTURAL MACHINERY.

Customs Duties on Agricultural Machinery in Foreign Countries. Statement, prepared at the Board of Trade, showing the rates leviable in the principal European countries and the United States, on machinery and implements imported from the United Kingdom. 800 w. Bd of Trd Jour—April, 1897. No. 12393. 30 cts.

ARGENTINE REPUBLIC.

United States Trade in the Argentine Republic. A table prepared to illustrate the position which the United States occupies in comparison with other countries; also report of tariff on the articles enumerated, and other information. 5000 w. Cons Repts—April, 1897. No. 12397. 45 cts.

COMMERCE.

The United States of America and the Far East. Editorial on work of the U. S. National Assn. of Manufacturers, and information given in their recent report. 2300 w. Engng—April 23, 1897. No. 12563. 30 cts.

COMPETITION.

German Competition with British Manufacturers in the Netherlands. W. Robinson. Extract from a report issued by the foreign office, reviewing the situation and expressing an opinion as to what are the chief obstacles to an extension of British trade. 900 w. Eng, Lond—March 26, 1897. No. 12099. 30 cts.

DUTIES.

Senator Elkins' Speech for Discriminating Duties. A speech in behalf of American shipping, to be published in five parts. Also editorial. 3300 w. Sea—April 8, 1897. Serial. 1st part. No. 12134. 15 cts.

EXPORTS.

Our Export Trade. Charles R. Flint. Reviews the industrial life of the past, the changed conditions, the necessity for widening our field of distribution, and the steps to be taken, and the effect a great export trade would have on the United States. 3400 w. Forum—May, 1897. No. 12554. 30 cts.

EXPOSITION.

The Russian Exposition at Nijni-Novgorod.

(L'Exposition Nationale Russe de Nijny-Novgorod.) A general review of the present state of Russian industries, from a report made to the French Society of Civil Engineers. 7500 w. Moniteur Industrielle—Jan. 2, 1897. No. 12489. 30 cts.

GERMANY.

German Capital and German Industry. The interest taken in industrial enterprises and the causes which have made these enterprises safe investments. 1200 w. Cons Repts—April, 1897. No. 12396. 45 cts.

ITALY.

Competition with British Trade in Italy. Discusses some of the important factors favoring German competition. 2500 w. Bd of Trd Jour—April, 1897. No. 12391. 30 cts.

JAPAN.

Japan. Its Resources, Industries, and Markets, with Special Reference to British Trade. Considers Japan first as a customer, and second as a competitor, giving much interesting information of the country. 10000 w. Ir & Coal Trds Rev—April 9, 1897. No. 12249. 30 cts.

PRICES.

The Late Prices Reaction. A table of comparative prices of 108 stable articles, raw and manufactured products, produce, cattle and meats, at quarterly intervals, showing fluctuations in quotations from July 1, 1892, to April 1, 1897, covering the period of recent extreme depression, with comment. 4000 w. Bradstreet's—April 10, 1897. No. 12144. 15 cts.

RUBBER Shoes.

A Short History of Rubber-Shoe Prices. The problem of prices, its importance, lists of prices in 1852 and 1864, &c. 1400 w. Ind Rub Wld—April 10, 1897. No. 12383. 45 cts.

The Reduction in Rubber-Shoe Prices. Statements regarding the rubber-shoe trade showing that prices average 16% lower than last year. 4400 w. Ind Rub Wld—April 10, 1897. No. 12382. 45 cts.

SCIENTIFIC Apparatus.

Should the Manufacture of Scientific Apparatus in this Country Be Protected and Encouraged by a Tariff? A. A. Ziegler. Favoring a duty and discussing this question. 2000 w. Elec Rev—April 14, 1897. No. 12191. 15 cts.

TARIFF.

Comparison of Iron and Steel Duties in the Wilson Tariff and the Dingley Bill. A careful comparison of the duties on iron and steel and manufactures of iron and steel. 1700 w. Bul of Am Ir & St Assn—April 10, 1897. No. 12121. 15 cts.

Tariff Changes and Customs Regulations. Russia, Sweden, Germany, German East Africa, Belgium, France, France-Tunis, France-Madagascar, South East Africa, Italy, Austria-Hungary, Mexico, Costa Rica, United States of Colombia, Ecuador, Argentina, Siberia, South African Republic, British India, Mauritius, Sierra Leone and Queensland. 7000 w. Bd of Trd Jour—April, 1897. No. 12394. 30 cts.

The Dingley Tariff Bill. Robert P. Porter. Discusses tariff bills in general and the Dingley bill in particular, in a manner quite favorable to the bill. 3800 w. N Am Rev—May, 1897. No. 12509. 45 cts.

TRADE.

Japan and Australia. Editorial comment on a new line of steamers inaugurated between these countries, and the effect on trade. 1300 w. Engng—April 16, 1897. No. 12352. 30 cts.

TRUSTS.

Industrial Combinations. George T. Oliver. Explains consolidations, trusts, pools, &c., their operations, and good and evil effects, with arguments advanced by the advocates of these organizations. Also suggests a plan for solving the problem of industrial combinations. 4000 w. Forum—May, 1897. No. 12555. 30 cts.

"Trusts" in Japan. Editorial comment on the economic conditions relating to the evolution of commerce and industry in the direction of combination. 1000 w. Engng—April 23, 1897. No. 12561. 30 cts.

CURRENCY AND FINANCE.

FINANCE.

The Austrian Budget for 1897. (Das Oesterreichische Finanzgesetz für das Jahr 1897.) The detailed government report, giving the estimates and expenses for all the engineering and building improvements in the Empire. Valuable for statistical purposes. 15000 w. Oesterr. Monatschr. f. d. Oeffent. Baudienst—March, 1897. No. 12419. 30 cts.

PRODUCTION.

The Increased Production of Gold. Galusha A. Grow. Conclusion of a speech in the House of Representatives. Showing that there is gold enough in the world for standard money. 1300 w. Bul of Am Ir & St Assn—April 20, 1897. No. 12280. 15 cts.

GOVERNMENT CONTROL.

TRAFFIC.

Traffic Legislation. Editorial review of a lecture by J. H. Balfour Browne, delivered before the London Chamber of Commerce, giving the history of English legislation in connection with this subject. 1700 w. Engng—April 16, 1897. No. 12350. 30 cts.

TRANS-MISSOURI.

The Trans-Missouri Case. Full text of the opinion of justices White, Field. Gray and Shiras who dissent from the opinion of the majority of the U. S. Supreme Court. Also editorial. 12500 w. Ry Age—April 2, 1897. No. 12061. 15 cts.

LABOR.

ARBITRATION.

Arbitration in the Northeastern Dispute. A recapitulation of the facts with comment. 1800 w. Trans—April 2, 1897. No. 12157. 30 cts.

BANKING.

Governmentalism versus Individualism in Relation to Banking. Austin W. Wright. Reply to an article in Gunton's Mag. entitled "How Not to Reform the Currency," in which the views of the writer, as expressed in a previous article, were criticised. 6000 w. Elec Engng—May 1, 1897. No. 12589. 15 cts.

LABOR.

Employer and Employé. (Brief account of a meeting of railway officers and Brotherhood Men at Grand Rapids. 2500 w. Ry Age—April 9, 1897. No. 12151. 15 cts.

MISCELLANY.

EDUCATION.

Industrial Education. R. H. Thurston, in the N. Y. Tribune. The lesson taught by Germany in her great governmental system of technical education and its results. 2000 w. W Elec—April 24, 1897. No. 12302. 15 cts.

IMMIGRATION.

Should Immigration Be Restricted? Simon Greenleaf Croswell. Setting forth and investigating facts bearing upon the problems involved and the conclusions to which they point. 4400 w. N Am Rev—May, 1877. No. 12507. 45 cts.

MEXICO.

American Enterprise in Mexico. Comment on the experience of American capitalists who have invested their resources in Mexican railways. 1000 w. Engng—April 16, 1897. No. 12353. 30 cts.

PROGRESS.

Progress of the United States. Michael G. Mulhall. Part I. The New England States. Studies the subject from the views of population, industry and wealth. 2400 w. N Am Rev—May, 1897. Serial. 1st part. No. 12508. 45 cts.

ELECTRICAL ENGINEERING.

LIGHTING.

ALTERNATING CURRENT.

Profitable Day Load in Alternate Current-Systems. George T. Hanchett. Suggestions for combining a lighting system with power distribution during the day. Also editorial criticism. 2000 w. Elec Wld—April 24, 1897. No. 12348. 15 cts.

See same title under Electrical Engineering. Power.

ARC Lamps.

Arc Lamps for Street Lighting. Thomas Hesketh. A consideration of the qualifications desirable. 1200 w. Elect'n—April 9, 1897. No. 12248. 30 cts.

BELGIUM.

Coöperative Electric Lighting in the Village of Borsbeke, Belgium. H. Schoentjes. An account of the electric lighting system of this small commune. 1000 w. Elec Eng—April 28, 1897. No. 12378. 15 cts.

CENTRAL Stations.

Combination of Central Electric Lighting Stations with Water Works. (Elektrische Beleuchtungszentralen in Verbindung mit Wasserwerken.) Discussing the economy of the combination, and showing the workings of the central station at Cologne. 1500 w. Die Elektrizität—Feb. 27, 1897. No. 12475. 30 cts.

COMPOSITE Station.

The Narragansett Electric Lighting Co. The Evolution of a Typical Composite Station. Joseph Wetzler. Illustrated description in detail, with editorial comment. 5500 w. Elec Eng—April 7, 1897. No. 12120. 15 cts.

FUSES.

Fuses for Branch Circuits. S. H. Sharpsteen. Considers the matter of fuse lengths for circuits of about 100 volts entering buildings for incandescent work. 1500 w. Elec Eng—April 21, 1897. No. 12282. 15 cts.

GEORGETOWN, D. C.

The Station of the Potomac Light and Power Company, Georgetown, D. C. N. Monroe Hopkins. Illustrated description. 400 w. Elec Eng—April 28, 1897. No. 12377. 15 cts.

INCANDESCENT Lamp.

Conductivity of Incandescent Carbon Filaments, and of the Space Surrounding Them. John W. Howell. The first part of the paper is in the nature of a discussion of a paper read by Prof. Anthony; and the second part is a discussion of the paper upon the "Edison Effect" in incandescent lamps which was read by Prof. Houston. Discussion follows. 10000 w. Trans Am Inst of Elec Engs—Feb., 1897. No. 12111. 45 cts.

Some Notes on the Manufacture of Incandescent Lamps. Fred De Land. Part first describes the process of properly preparing the filaments. 1500 w. Elec Engng—April 15, 1897. Serial. 1st part. No. 12233. 15 cts.

The Economy of Incandescent Lamps. (Ueber Oekonomie von Glühlampen.) A paper by Dr. Weber before the Electrotechnical Society, maintaining the greater economy of the incandescent electric lamp over the Welsbach gas burner. 1000 w. Elektrotechnische Zeitschr—March 25, 1897. No. 12465. 30 cts.

The Edison Lamp Connection. (Die Edison Fassung.) A discussion of the Edison screw fastening for incandescent lamps in comparison with a number of other devices for the same purpose. 4500 w. Elektrotechnische Zeitschr—March 18, 1897. No. 12461. 30 cts.

LAMPLIGHTING.

Electric Lighting of Oil Lamps. (Ueber Elektrische Fernzündung von Oellampen.) A drop of oil is lighted by contact with an incandescent platinum wire and the resulting flame communicated to the wick. 2500 w. Elektrotechnische Rundschau—March 1, 1897. No. 12476. 30 cts.

LAMPS.

The Automatic Extinction of Lamps. Describes a device in use at Portsmouth, Eng., where each lamp pillar carries an arc lamp as well as two incandescent lamps, by which the arc lamps are automatically put out and the incandescent lighted at midnight. Ill. 1000 w. Elec Rev, Lond—March 26, 1897. No. 12103. 30 cts.

LIGHTING.

Electric Lighting of the New Armory of the Ninth Regiment, N. G. S. N. Y. Illustrated description of an interesting installation where the entire lighting of the main drill hall is ac-

complished by means of ordinary two-in-series open arcs. 1100 w. Elec Wld—April 3, 1897. No. 12092. 15 cts.

LIGHTING Plant.

A Public Park Lighting Plant. P. M. Heldt. Describes and illustrates the new plant in Chicago which supplies current for the chain of parks and boulevards on the west side. 2000 w. Am Elect'n—April, 1897. No. 12286. 25 cts.

MALTA.

Malta Electricity Supply. Illustrated detailed description of works undertaken by the government of Malta. Interesting to engineers and members of local authorities. 1200 w. Eng, Lond—April 2, 1897. No. 12150. 30 cts.

PHOTOGRAPHY.

Electricity and Photography. Details of electrical apparatus used in a studio making it possible to take photographs at any time, irrespective of the state of the atmosphere. Ill. 1300 w. Elec Eng, Lond—March 26, 1897. No. 12101. 30 cts.

NORWICH, England.

Electric Lighting in Norwich, England. Herbert C. Gunton and Harold Lomas. Illustrated detailed description. 1500 w. Elec Wld—April 10, 1897. No. 12171. 15 cts.

RECONSTRUCTION.

Reconstruction of the Alternating Current System of the Royal Electric Company, Montreal, Canada. P. G. Gossler. An illustrated account of the reconstruction of an alternating current system supplying current to a large territory. 2700 w. Can Elec News—April, 1897. No. 12129. 15 cts.

STORAGE Battery.

Storage Battery Plant in a Brooklyn Lighting Station. Illustrated description of an interesting accumulator installation in the second district station of the Edison Illuminating Co. 1000 w. Elec Rev—April 7, 1897. No. 12105. 15 cts.

The Scotia Street Storage Battery Station of the Boston Edison Co. Illustrated description. 1200 w. Elec Eng—April 21, 1897. No. 12281. 15 cts.

WORCESTER.

The Extension at Worcester. Information from the report of Mr. Ruthven Murray, the city electrical engineer. Day plant, switchboard, sliding scale and no meter rent. 1600 w. Elec Rev, Lond—April 2, 1897. No. 12168. 30 cts.

POWER.

ACCUMULATORS.

Accumulators for Rapid Charging. L. Epstein. Reviews the opinions of M. Blanchon as expressed in a paper read before the Société International des Électriciens, and objects to his conclusions. 1500 w. Elec Rev, Lond—April 16, 1897. No. 12322. 30 cts.

Tests of a Gülcher Accumulator. (Untersuchung eines Gülcher-Akkumulators.) The Gülcher plate is composed of lead wires and spun glass. Tests under various conditions of charging and discharging show excellent efficiency, with much less weight than existing forms. 3000 w. Elektrotechnische Zeitschr—March 18, 1897. No. 12462. 30 cts.

The Ribbe Accumulator.¶ |Illustrated description of an accumulator which the inventor claims to be especially adapted to the propulsion of cars or other vehicles. 1400 w. Eng, Lond—April 23, 1897. No. 12534. 30 cts.

See same title under Electrical Engineering, Telegraphy and Telephony.

ALTERNATING Current.

Alternating Current Dynamos in Parallel. J. E. Woodbridge. Describes treatments which seem to work well in practice. 2800 w. Elec Eng—April 28, 1897. Serial. 1st part. No. 12381. 15 cts.

Recent Developments in Alternate Current Machinery, with Special Reference to the Ganz System. Alfred Dubsky. A short description of the newer alternating current machinery which has been constructed at the Ganz works at Budapest during the last few years. 2700 w. Elect'n—April 16, 1897. Serial. 1st part. No. 12360. 30 cts.

The Transmission of Power to Long Distances by Alternating Currents of Electricity. W. B. Esson. Discusses the subject under the headings of generators, conductors, and motors. Discussion follows. 12000 w. Jour of Soc of Arts—March 26, 1897. No. 12060. 30 cts.

See same title under Electrical Engineering, Light.

CURRENTS.

Electric Currents and Subdivision Systems. (Elektrische Strom und Stromverteilungssysteme.) A series of articles of a general and descriptive character, rather elementary. 10000 w. 5 articles. Die Elektrizität—Jan. 2, 16, Feb. 13, March 13, 27, 1897. No. 12471. 30 cts. each number.

Utilization of Multi-Phase Currents in Electric Driving. Percy Nicholls. Deals with the advantages of, or objections to, the system for short distance transmission, and the principles underlying the construction and action of these machines. Ill. 3600 w. Prac Eng—April 9, 1897. No. 12236. 30 cts.

ELECTRIC Plant.

Electric Light, Power and Heating Plant at the Rothschild Shirt Factory, Trenton, N. J. Illustrated description. 2400 w. Elec Wld—April 17, 1897. No. 12278. 15 cts.

ELECTRIC Power.

See same title under Marine Engineering.

ELEVATOR.

A Safety Electric Elevator. (Bahnartig Betriebener Elektrischer Sicherheits Aufzug.) The car revolves around its vertical axis and screws its way up a spiral track carried around the interior of the circular shaft. 1500 w. Deutsche Zeitschr für Elektrotechnik—February, 1897. No. 12455. 30 cts.

Electric Elevators. A brief review of hoisting mechansms used since the earliest ages is given, and the early history of the electric motor as applied to elevator machinery. Ill. 2500 w. Elec Wld—April 3, 1897. Serial. 1st part. No. 12091. 15 cts.

FACTORY.

Electricity in an Oil Cloth Factory. S. Ashton Hand. Illustrated description of the power and lighting plant recently installed in the factory of the Farr & Bailey Mfg. Co., of Camden, N.

J. 1000 w. Mach, N. Y.—May, 1897. No. 12570. 15 cts.

FRESNO Plant.

Some details of the Fresno Plant. C. E. Dutcher. Illustrated description of technical details of the electrical operation of the plant. 4500 w. Jour of Elec—April, 1897. No. 12371. 15 cts.

GENERATORS.

See same title under Street and Electric Railways.

HARROGATE.

Harrogate Electricity Works. Illustrated detailed description. 5000 w. Elec Eng, Lond—April 9, 1897. No. 12250. 30 cts.

HAULAGE.

See same title under Mining and Metallurgy, Mining, and title "Electric Haulage," under Railroad Affairs, Transportation.

HOISTS.

See same title under Mining and Metallurgy, Mining.

LOCOMOTIVE.

See Railroad Affairs, Maintenance of Equipment.

MOTORS.

Application of Electric Motors to the Textile Industry. (Les Applications des Moteurs Electriques a l' Industrie Textile.) Shows motors operating line shafting and also independent looms as applied in Switzerland and France. 2500 w. La Revue Technique—March 25, 1897. No. 12424. 45 cts.

Asynchronous Alternating Motors. (Ueber Asynchrone Wechselstrommotoren.) A mathematical investigation of the conditions of best action and efficiency of one- and three-phase electric motors. 2500 w. Elecktrotechnische Zeitschr—March 25, 1897. No. 12464. 30 cts.

MULTIPHASE.

Multiphase Generators and Motors. (Die Drehstrom-Dynamomaschunen und Drehstrom-Motoren.) A general explanation of the principles together with an illustrated description of the machines of the Allgemeine Elektrizitäts-Gesellschaft of Berlin. Three articles, 7500 w. Die Elektrizität—Feb. 27, March 13, 27, 1897. No. 12474. 30 cts. each.

NIAGARA.

Electrical Development at Niagara Falls. The demands for power and the arrangements being made to supply; a brief description of the new wheel pit, &c. Ill. 600 w. Elec Rev—April 14, 1897. No. 12190. 15 cts.

PHILADELPHIA.

Cause of Fire at Union Traction Company's Power House, Philadelphia. Report of William McDevitt to the Philadelphia Fire Underwriters' association. 1000 w. W Elect'n—May 1, 1897. No. 12524. 15 cts.

POWER Plant.

Power Plant of the Tennessee Centennial and International Exposition at Nashville, Tenn. Brief illustrated description. 500 w. Power—May, 1897. No. 12558. 15 cts.

POWER Transmission.

Electric Power Transmission Project in the Mohawk Valley. Orrin E. Dunlap. Brief account of the project for developing the power of West Canada Creek at Trenton Falls. Ill. 500 w. W Elect'n—May 1, 1897. No. 12523. 15 cts.

Electricity—Including a Short Review of Transmission of Power by Electricity and Compressed Air. F. B. Griffith. A non debatable paper. Presents a few rules and principles which were evolved by experiments made by eminent electricians, points out some of the uses and advantages of electricity in railroad shops, &c. Ill. 1600 w. Pro of Cent R'way Club—March, 1897. No. 12234. 45 cts.

Electric Power Transmission in Factories. Describes the recent installation of Messrs. Chadwick, Limited, with remarks. The plant is considered very complete. 2500 w. Elec Rev, Lond—April 16, 1897. No. 12320. 30 cts.

The Rheinfelden Power Transmission. The history of the scheme, with description of the power house, turbines, plant and distribution. Ill. 3500 w. Elect'n—March 26, 1897. No. 12096. 30 cts.

PUMPING by Electricity.

See "Electric Pumps" under Municipal Engineering, Water Supply.

RESISTANCE.

A Practical Resistance Device. (Ein Praktischer Belastungs-Wiederstand.) A resistance for testing generators, &c., composed of sheet-iron plates immersed in casks of water. A constant stream of water flows through the casks, maintaining a uniform temperature. 1500 w. Deutsche Zeitschr. f. Elektrotecknik—February, 1897. No. 12454. 30 cts.

SAW MILL.

Electric Saw Mill at Folsom, Cal. Illustrated description of the application of electric power to the driving of saw mills. 600 w. Elec Eng—April 28, 1897. No. 12379. 15 cts.

TIFFANY Factory.

Electric Power Plant of the Tiffany Factory at Forest Hill, N. J. Illustrated description of this recent installation. 1100 w. Elec Wld—April 10, 1897. No. 12170. 15 cts.

TRACTION.

See "Haulage," above; "Electricity," under Railroad Affairs, Miscellany; and "Electric Traction" under Street and Electric Railways.

TRANSFORMERS.

Formulæ for Transformers. Alexander Russell. In proving the formulæ in this paper no assumptions have been made as to the shape of the curve of the applied electromotive force, or as to the shape of the permeability curve of the iron core. Formulæ are found for the ordinary transformer with a non-inductive load, then with inductive loads and condenser loads. Also methods of boosting and compensating are discussed. 4500 w. Elect'n—March 26, 1897. No. 12097. 30 cts.

TELEGRAPHY AND TELEPHONY.

ACCUMULATORS.

The Installation of Accumulators at the Main Telegraph Office in Paris. (Akkumulatorenein richtung auf dem Haupt Telegraphenamt in Paris.) Since 1895, 11000 Calland cells have been replaced by Tudor, and Laurent-Cély storage batteries, of which full details are given. 3000 w. Elektrotechnische Zeitschr—March 18, 1897. No. 12463. 30 cts.

BELL Telephone Co.
The American Bell Annual Report. The extent of the service and amount of yearly business. 2000 w. Elec Rev—April 28, 1897. No. 12390. 15 cts.

BERLINER Case.
The Probable Decision in the Berliner Case. E. F. Frost. An attempt to forecast the outcome of this case, predicting that the Government will win its suit to annul the Berliner patent on every count. 1200 w. Elec Wld—April 17, 1897. No. 12276. 15 cts.

CABLE.
The German-Norwegian Cable. Alb. Petersen. Describes changes which improved the telegraphic connections between Germany and Norway to such an extent, that the cable, by means of well regulated instruments, is now able to transmit about 2½ times more traffic than before. Diagram. 1500 w. Elec Rev, Lond—March 26, 1897. No. 12104. 30 cts.

CABLE Speeds.
The Function of the Element in Cable Speeds. E. Raymond-Barker. Investigations of the writer, intended to give some light on this subject. A suggestion of a standard method for conducting really satisfactory trials of speed on laid cables, with the view to the data being adopted as basis for future calculations in the design of cable cores. 2500 w. Elec Rev, Lond—April 16, 1897. No. 12321. 30 cts.

CABLE Steamer.
The French Cable Steamer "Portena." Description of the third cable steamer built by Messrs. Johnson & Phillips for the Compagnie Française des Cables Télégraphiques. 1800 w. Elect'n—April 2, 1897. No. 12163. 30 cts.

RAPID Telegraph.
High Speed Telegraphy. Editorial on the system of Messrs. Crehore & Squier. 1000 w. Elec Eng—April 28, 1897. No. 12380. 15 cts.

SUBMARINE Telegraphy.
The Commencement of Submarine Telegraphy. J. H. Jackson, in the Nautical Magazine. Account of early attempts, giving the palm to a Russian scientist, Prof. Soemmering 1100 w. Sci Am Sup—April 24, 1897. No. 12293. 15 cts.

TELEPHONE Exchange.
The New Telephone Exchange in Christiana. (Das neue Fernsprechamt in Christiana.) A fully illustrated description of one of the most recent modern exchanges in Europe, with full details including the application of dynamos and storage batteries. 8000 w. Elektrotechnische Zeitsch—April 1, 1897. No. 12468. 30 cts.

A Modern Telephone Station. C. E. Kammeyer. Illustrated description of the station at the corner of 47th St. and Kedzie avenue, Chicago. 1800 w. Elec Rev—April 28, 1897. No. 12389. 15 cts.

TELEPHONE Lines.
Reconstruction of the Telephone Lines in Westchester County, N. Y. Details of improvements to be made, with schedule of charges obtaining in this district. 1000 w. Elec Eng—April 21, 1897. No. 12283. 15 cts.

TELEPHONE Rates.
Telephone Rates in New York. Argument against the Brush bill to regulate telephone charges. 1100 w. Elec Rev—April 14, 1897. No. 12192. 15 cts.

MISCELLANY.

ARMATURES.
The Reaction of Eddy Currents upon Armatures. (Die Anker Rückwirkung der Wirbelströme.) A mathematical and graphical investigation. 1500 w. Elektrotechnische Zeitschr—March 11, 1897. No. 12459. 30 cts.

BATTERIES.
Thermo-Electric Batteries. C. J. Reed. Describes the two general classes of thermo-electric batteries and their action. 3000 w. Am Elect'n—April, 1897. No. 12288. 25 cts.

CATHODE Rays.
Mr. Swinton on Cathode Rays. Some interesting and unexpected properties as developed in the focus tube generally employed for the production of Röntgen rays, presented in a paper read before the Royal Soc. Ill. 1400 w. Elec Rev, Lond—April 9, 1897. No. 12240. 30 cts.

Some Experiments with Cathode Rays. A. A. C. Swinton. Abstract of a paper read before the Royal Society. Investigation of the discharge in Crookes' tubes. Illustrated description of experiments from which it seems that X-rays can only be produced by Cathode rays when these strike solid matter. 3300 w. Nature—April 15, 1897. No. 12323. 30 cts.

CONDUIT.
Construction of Chicago Edison Company's Underground Conduit in Jackson Street. Illustrated description of work now being executed, which embodies every advancement known to the art. 1500 w. W Elec—April 24, 1897. No. 12301. 15 cts.

CONVERTER.
A Rotating Liquid Converter. Henry S. Carhart. Describes a simple device to convert a direct current from any source, such as a storage battery, into alternating currents of one, two or three phases, and applies the principle involved to an explanation of the rotating converter. 1600 w. Am Elect'n—April, 1897. No. 12289. 25 cts.

CORES.
The Insulation of Armature Cores. Louis Illmer, Jr. Considers the manner in which the general types of armatures are insulated. Ill. 1600 w. Am Elect'r—April, 1897. No. 12287. 25 cts.

CURRENTS.
Transmission of Heavy Currents. G. H. B. Zahn. A study of the various systems used, of conductors, and insulating materials, &c. 4000 w. W Elec—April 17, 1897. No. 12223. 15 cts.

ELECTRICAL History.
Epoch-Making Events in Electricity. G. H. Stockbridge. Considering Oersted's discovery, and Ampere's work as a logical sequence thereof. Second paper. 4300 w. Eng Mag—May, 1897. No. 12582. 30 cts.

ELECTRICITY and Magnetism.
The Nature of Electricity and Magnetism. (Das Wesen der Elektrizität und des Magnetismus.) A series of articles treating of the molecu-

lar theory of Vogt. Three articles. 7,500 w. Die Elektrizität—Jan. 2, 16, 30, 1897. No. 12472. 45 cts.

ETHICS.

Ethics of Modern Science. S. Alfred Varley. A criticism of a recent lecture by Prof. Ayrton, with remarks on electrical matters. 3000 w. Elec Rev, Lond—April 2, 1897. No. 12169. 30 cts.

FUMES.

On Electrical Properties of Fumes Proceeding from Flames and Burning Charcoal. Lord Kelvin and Dr. Magnus Maclean. Read at meeting of Royal Soc. Describes experiments made and gives results. Ill. 1800 w. Nature—April 22, 1897. No. 12591. 30 cts.

GASEOUS Fuel.

Gaseous Fuel as a Means of Cheapening Electricity. Nelson W. Perry. Suggestions for decreasing the expenses of electrical plants. 3500 w. Am Gas Lgt Jour—April 5, 1897. No. 12067. 15 cts.

INSTRUMENTS.

New Universal Register, Galvanometer and Insulation Measure by Siemens & Halske. (Ueber ein Universal Registririnstrument, Universal Galvanometer und Isolationsmesser von Siemens & Halske.) Giving full details of construction and use of three new and valuable instruments. 5000 w. Elecktrotechnische Zeitschr—April 1, 1897. No. 12469. 30 cts.

INSULATION.

Measurement of Insulation in Systems of more than Two Conductors. (Ueber Isolationsmessungen auf Systemen von mehr als Zwei Leitern, &c.) A mathematical treatment, giving analytical relations for a great variety of combinations. 7500 w. Elektrotectnische Zeitschr—March 11, 1897. No. 12458. 30 cts.

MAGNETISM.

Magnetism for Engineers. An article written for the benefit of engineers, who do not see things in the same light as the pure scientist, in an endeavor to elucidate some of those conceptions of the scientific mind which are a frequent cause of bewilderment to the electrical engineer. 3800 w. Elec Rev, Lond—March 26, 1897. No. 12102. 30 cts.

MAGNETS.

The Calculation of Wires for Magnets. George T. Hanchett. A number of formulæ for coils and cores of different sections, together with the meanings of their reference letters. 400 w. Elec Wld—April 17, 1897. No. 12277. 15 cts.

OPTICS.

I. Optics and the Theory of Ions. Dr. P. Zeeman. II. Preliminary Note upon the Broadening of the Sodium Lines by Intense Magnetic Fields. A. St. C. Dunstan, M. E. Rice and C. A. Kraus. The first article explains an important discovery, valuable from its bearing upon the theories of light and other forms of radiant energy. The second article gives experiments verifying Dr. Zeeman's discovery. 1400 w. Elec Wld—May 1, 1897. No. 12531. 15 cts.

PLANT Growth.

The Influence of Electricity upon the Growth of Plants. (Einfluss der Elektrizität auf das Wachstum der Pflanzen.) Giving an interesting résumé of the subject showing the effect to vary with the nature of the plant: also the use of electricity to destroy injurious germs. 2000 w. Die Elektrizität—Feb. 13, 1897. No. 12473. 30 cts.

REPAIRS.

Repairs of Electrical Machinery—Field Coils. A. R. Harris. How to remedy defects and the temporary expedients that may be resorted to in case of failure of field coils, is the subject of part first. 2600 w. Am Mach—April 22, 1897. Serial. 1st part. No. 12296. 15 cts.

ROENTGEN Rays.

Do the Röntgen Rays Make Air a Conductor? G. M. Minchin. Experimental study and explanations, reaching a negative result. 2300 w. Elect'n—April 9, 1897. No. 12247. 30 cts.

See also Cathode Rays, above.

THERMOELECTRICITY.

The Theory of Thermoelectricity. (Ueber die Theorie der Thermoelektrizität.) A mathematical treatment of the subject based upon the laws of the conductivity of heat. 1500 w. Elektrochemische Zeitschr—March, 1897. No. 12453. 30 cts.

TRANSFORMERS.

Practical Transformer Calculation. Franz J. Dommerque. The method of calculation is explained. 1800 w. Elec Engng—May 1, 1897. No. 12590. 15 cts.

VIBRATIONS.

Electricity and Electrical Vibrations. Review of a course of lectures recently delivered by Lord Rayleigh. The six lectures included discussion of induction, alternating currents, currents of very high frequency, vibrations, &c. 2800 w. Col Guard—April 23, 1897. No. 12564. 30 cts.

MARINE ENGINEERING.

AMERICAN Shipping.

Charles H. Cramp on American Shipping. Paper read before a conference held in the committee room of the Senate Committee on Commerce. An interesting discussion of the means and methods required for the development of our merchant marine. 1700 w. Ir Age—April 15, 1897. No. 12200. 15 cts.

See also title "Duties" under Economics and Industry, Commerce and Trade.

ARMOR PLATE.

See same title under Mining and Metallurgy, Iron and Steel.

BOILERS.

Navy Boilers. Editorial on the merits of water-tube boilers, especially the Belleville, and

support of Mr. Durston, with criticism of the Scotch boiler. 1700 w. Eng, Lond—April 16, 1897. No. 12327. 30 cts.

CABLE Steamer.

See Electrical Engineering, Telegraphy and Telephony.

CRUISERS.

Recent Trials of the Cruisers "Powerful" and "Terrible." A. J. Durston. Read before the Inst. of Naval Arch'ts. A description of the trials with data obtained therefrom. Also discussion. 10000 w. Engng—April 9, 1897. No. 12231. 30 cts.

ELECTRIC Power.

Application of Electrical Transmission of Power in Marine Engineering and Shipbuilding. F. Von Kodolitsch. Read before Inst. of Naval Arch'ts. Shows the usefulness of light portable machine tools in marine engineering, when electrically driven. 2300 w. Ind & Ir—April 15, 1897. Serial. 1st part. No. 12346. 30 cts.

ENGINES.

New Horizontal Engines for U. S. Cruiser Chicago. Illustrated description of the new machinery with which the vessel is to be fitted. 1500 w. Marine Engng—April, 1897. No. 12107. 30 cts.

Lining a Vertical Marine Engine. James V. Trenton. Directions with diagram. 1000 w. Sta Eng—April, 1897. No. 12135. 15 cts.

FERRYBOAT.

Origin and Development of the Ferryboat. A. E. Stevens. Calls attention to the conditions which have made New York pre-eminent in the specialty of ferryboats, and briefly describes some of the early designs. Ill. 1100 w. Marine Engng—April, 1897. No. 12110. 30 cts.

GERMAN NAVY.

The Newest Vessels of the German Navy. From Ueber Land und Meer. Illustrated brief description of the Kaiser Friedrich III and the cruiser K. 600 w. Sci Am Sup—April 10, 1897. No 12122. 15 cts.

HIGH-PRESSURES.

High Steam Pressures on Sea Going Ships and in General. Dr. R. H. Thurston. Reviews the advance in pressures and expansion in part first. 1100 w. Marine Engng—April, 1897. Serial. 1st part. No. 12109. 30 cts.

IRONCLADS.

On the Fighting Value of Certain of the Older Ironclads if Re-Armed. Charles Beresford. Read before the Inst. of Naval Arch'ts. The proposal to re-arm seventeen vessels; thirteen battleships and four cruisers. Also a list giving proposed armament for each, with comments on paper and discussion. 5400 w. Eng, Lond—April 16, 1897. No. 12326. 30 cts.

JAPAN.

The Growth of a Japanese Steamship Company. Comments on information contained in a handbook issued by the Japan Mail Steamship Co. of London. The history of the growth of maritime enterprise in modern Japan is briefly reviewed. 2000 w. Engng—April 2, 1897. No. 12161. 30 cts.

LIGHT-HOUSES.

Lighthouses. Alfred J. Glasspool. Part first comments on the need of placing these signals to guide vessels in safety, and reviews the early systems and the progress made in this field. 1800 w. Arch, Lond—April 16, 1897. Serial. 1st part. No. 12357. 30 cts.

MEAN Water-Line.

The Use of the Mean Water-Line in Designing the Lines of Ships. A. G. Ramage. Read at session of the Inst. of Naval Arch'ts. Explains method, giving table of results. 600 w. Eng, Lond—April 16, 1897. 12328. 30 cts.

PROPULSION.

The Application of the Compound Steam Turbine to the Purpose of Marine Propulsion. Chas. Parsons. Read at session of Inst. of Naval Arch'ts. Describes the fitting of the Turbinia with turbine engines, and the result as far as ascertainable. 2000 w. Eng, Lond—April 16, 1897. No. 12329. 30 cts.

REVENUE Cutters.

Machinery of U. S. Revenue Cutters Nos. 4 and 5 for the Great Lakes. Brief illustrated description. 350 w. Am Mach—April 15, 1897. No. 12255. 15 cts.

SHIP Construction.

Recent Developments in Mercantile Ship Construction. Part first calls attention to certain tendencies and developments now in progress in regard to the details of ship construction. 1500 w. Eng, Lond—April 23, 1897. No. 12533. 30 cts.

STABILITY.

Ascertaining the Stability of Ships. A. G. Ramage. Read before the Inst. of Naval Arch'ts. Illustrated description of a mechanical method of ascertaining the statical stability of ships. 1000 w. Engng—April 9, 1897. No. 12227. 30 cts.

STEERING Gear.

The Steering Gear of the Battleship Fuji. Drawings with explanatory diagrams and description of Cameron's patent self-regulating steering gear with which the ship is fitted. 1000 w. Eng, Lond—April 9, 1897. No. 12239. 30 cts.

VALVE Gears

Assistant Cylinder for Valve Gears, Basil H. Joy. Read before the Inst. of Marine Engs. Incorporated. Describes the machine and the principles, giving some practical results. 4000 w. Prac Eng—April 2, 1897. No. 12180. 30 cts.

WARSHIPS.

German and Foreign Warships. (Die Kriegsflotten Deutschlands und des Auslandes.) A comparison between the German Navy and other European powers, greatly to the disadvantage of the former. 2000 w. and large chart, Stahl und Eisen—April 1, 1897. No. 12437. 45 cts.

The United States Sea-Going Battleship "Iowa." Description with brief report of trial trip. Ill. 900 w. Am Eng & R R Jour—May, 1897. No. 12519. 30 cts.

The Alabama and the Prince George. A comparison between the dimensions and other features, with diagrams. 1800 w. Eng, Lond—April 2, 1897. No. 12149. 30 cts.

WATER-TUBE Boilers.

Water-tube Boilers in Warships. C. C. P. Fitzgerald. Read before the Inst. of Naval Arch'ts. A comparison of some of the general features of water-tube boilers with those of Scotch boilers which they are to supersede. 5000 w. Engng—April 9, 1897. No. 12230. 30 cts.

MECHANICAL ENGINEERING.

BOILERS, FURNACES AND FIRING.

BOILERS.
Proper Construction and Care of Boilers. J. M. Allen. Read before the Southern Ice Exchange, at Charleston, S. C. Extracts dealing with how to prevent boiler explosions. 1300 w. Bos Jour of Com—April 17, 1897. Serial. 1st part. No. 12216. 15 cts.

See also same title under Marine Engineering.

CHIMNEYS.
Calculation and Construction of Tall Chimneys. (Bau und Berechnung Hoher Schornsteine.) Paper by H. Bastine before the Saxon Branch of the Society of German Engineers. A full discussion of the strength of masonry chimneys to resist wind stresses. 5000 w. Zeitsch d. Vereines Deutscher Ingenieure—March 6, 1897. No. 12403. 30 cts.

On the Construction of a Factory Chimney of the Capacity to Suit a Plant of 2000 Horse Power. Robert Kunstman. Discusses the necessary examination of the ground, the foundation, and the shaft. Ill. 2300 w. Brick—April, 1897. No. 12064. 15 cts.

CORROSION.
Internal Corrosion in Boilers. Calls attention to the important influence of oxygen brought in with the water. 1600 w. Bos Jour of Com—April 24, 1897. No. 12316. 15 cts.

EFFICIENCY.
Test of the Cahall Boiler at the Armstrong Cork Works. Letter from Thomas Pray, Jr., replying to criticisms, with editorial remarks. 1800 w. Eng News—April 22, 1897. No. 12312. 15 cts.

EXPLOSION.
Steam Boiler Explosion at the Gratweiner Paper Mill. (Dampfkessel-Explosion in der Gratweiner Papier Fabrik.) An illustrated account of a destructive boiler explosion. The boiler was one of a battery of the Dupuis type, the rupture taking place along a newly riveted seam. 3000 w. and 1 plate. Oesterr Monatschr f. d. Oeffent Baudienst—March, 1897. No. 12420. 45 cts.

FEED-WATERS.
The Cure for Corrosion and Scale from Boiler Waters. Albert A. Cary. A consideration of the various methods for the removal or treatment of scale producing substances. Third paper. 6200 w. Eng Mag—May, 1897. No. 12585. 30 cts.

High Feed-Water Temperatures A. L. McClurg. Extract from a recent lecture before the Massachusetts Assn., treating of exhaust heaters and their value. 1300 w. Bos Jour of Com—May 1, 1897. No. 12593. 15 cts.

GRATE Area.
Ratio of Heating Surface, Grate Area, and Cylinder Volume. Angus Sinclair. A table giving the leading particulars concerning 25 of the latest built locomotives, with discussion of the proportions which produce the most economical locomotive for different kinds of service. 2300 w. Loc Eng—April, 1897. No. 12085. 30 cts.

HIGH Pressures.
See same title under Marine Engineering.

STEAM.
Economic Steam Raising and Utilization. Arthur Heischmann. A discussion of the questions affecting the efficency of boilers and engines, the systems in use, and the advantages of superheated steam. 2800 w. Mach, N. Y—May, 1897. No. 12574. 15 cts.

WATER-TUBE Boilers.
See same title under Marine Engineering.

COMPRESSED AIR.

AIR-LIFT Pump.
Theoretical and Practical Limitations of the Air Lift Pump. E. E. Johnson. Explains the operation and the conditions under which the air is discharged. 1200 w. Eng News—April 22, 1897. No. 12311. 15 cts.

FLUID Air.
Fluid Air for Industrial Uses. Describes methods of liquefying air, and some of the uses. 700 w. Cons Repts—May, 1897. No. 12526. 45 cts.

RAILWAY Service.
See title "Compressed Air" under Railroad affairs, Miscellany, and Street and Electric Railways.

TOOLS.
Machine Tools Operated by Means of Compressed Air. Describes in detail a device in use on planing machines, the invention of Mr. Alexander Gordon, of Hamilton, O. Sectional views. 1000 w. R R Gaz—April 30, 1897. No. 12538. 15 cts.

POWER-TRANSMISSION.
Long Distance Transmission of Power. W. O. Amsler. Information regarding the use of compressed air for this purpose. 3500 w. Sib Jour of Engng—April, 1897. No. 12297. 30 cts.

ENGINES AND MOTORS.

ENGINE.
The Littlejohn Perfectly Balanced Engine. Illustrated description. 2000 w. Am Ship—April 15, 1897. No. 12214. 15 cts.

See also same title under Marine Engineering.

EXPERIMENTS.
Steam Engine Experiments. Bryan Donkin. Results of seven steam-engine experiments. A brief summary of the trials. 800 w. Engng—April 9, 1897. No. 12224. 30 cts.

EXPLOSION Motors.
Explosion Engines at the Budapest Exhibition. (Die Explosionsmaschinen auf der Millenniums-Landesausstellung in Budapest 1896.) Illustrating a great variety of recent gas and petroleum motors. 5000 w. Zeitschr d. Vereines deutscher Ingenieure—March 27, 1897. No. 12408. 30 cts.

GAS Engines.
Experiments on the Combustion of Lighting Gas in Gas Engines. Describes the experiments

made and gives results. 2200 w. Prac Eng—April 16, 1897. No. 12355. 30 cts.

Care of Gas Engines. Extracts from a work by Mr. Hiscox, giving practical suggestions. 1100 w. Bos Jour of Com—May 1, 1897. No. 12594. 15 cts.

Some Possibilities of Power Generation by Gas Engines and the Utilization of Rejected Heat. Reid T. Stewart. Abstract of paper read before the Eng's Soc. of W. Penna., with editorial comment. The writer shows that 75% of the total heat is discarded and suggests ways of utilizing this heat. 4500 w. Am Eng & R R Jour—May, 1897. No. 12520. 30 cts.

The Olin Gas and Gasoline Engine. Illustrated description of an engine of the single-acting four-cycle type. 1000 w. Eng News—April 15, 1897. No. 12208. 15 cts.

PISTON Packing.

Piston Packing. F. F. Hemenway. Reviews the progress of piston packing, and the different materials used. Ill. 1300 w. Mach, N. Y.—May, 1897. No. 12572. 15 cts.

REGULATION of Steam Engines.

The Determination of the Degree of Irregularity of Steam Engines. (Ermittlung des Ungleichförmigkeitsgrades von Dampfmaschinen.) A method of computing the degree of inequality in the forces acting in a given engine to enable the proper weight of fly wheel to be computed. 3500 w. Zeitsch d. Oesterr Ing u. Arch Vereines—March 12, 1897. No. 12412. 30 cts.

ROTARY Engine.

The Principles and Development of the Rotary Engine. Elmer S. Farwell. Reviewing the attempts to supersede the reciprocating engine. 2800 w. Eng Mag—May, 1897. No. 12587. 30 cts.

SERIES Engine.

The Wellington Series Engine. An Entirely New System of Developing Power from Heat. A description of the principal features of a new form of heat engine which promises to effect remarkable results. With editorial. 5500 w. Eng News—April 8, 1897. No. 12137. 15 cts.

STEAM ENGINES.

Steam Engines at the Swiss National Exposition at Geneva, 1896. (Schweizerische Nationalausstellung in Genf. 1896. Die Dampfmaschinen). Describes and illustrates engines by the leading builders of Switzerland, including compound and triple expansion stationary, and lake steamer engines. 2500 w. and 2 plates. Zeitschr d. Vereines deutscher Ingenieure—March 6, 1897. No. 12401. 30 cts.

The Accelerity Diagram of the Steam Engine. J. Macfarlane Gray. Read at session of the Inst. of Naval Arch'ts. Explanation of method, with diagrams. 1800 w. Ind & Ir—April 15, 1897. No. 12345. 30 cts.

The Carels High-Speed Steam Engine. (Machine à Vapeur à Grand Vitesse, Système Carels.) A compound single-acting engine with two sets of cylinders, with rotary valves, the whole encased after the manner of the Westinghouse engine. 2000 w. La Revue Technique—March 25, 1897. No. 12426. 45 cents.

SWISS Engines.

The Steam Engines at the Geneva Exposition. (Die Dampfmaschinen an der Schweiz. Landesausstellung in Genf. 1896.) With illustrations of compound engines and air compressor by leading Swiss builders. Two articles. 5000 w. Schweizerische Bauzeitung—March 20 & 27, 1897. No. 12409. 30 cts.

VALVE-GEARS.

See same title under Marine Engineering.

POWER AND TRANSMISSION.

COMPRESSED Air.

See title "Power Transmission" under Mechanical Engineering. Compressed Air.

ELECTRICAL Transmission.

See title "Power Transmission" under Electrical Engineering, Power.

EXPOSITION.

Power Exhibits at the Nuremberg Exposition (Die Kraftmaschinen auf der II bayerischen Landesausstellung in Nürenberg.) With illustrations of double deck boilers and a variety of engines by leading German builders. Two articles, and plates, 10000 w. Zeitsch d. Vereines deutscher Ingenieure—March 20 & 27, 1897. No. 12405. 30 cts.

POWER.

The Power Problem. J. C. Ranson. A consideration of the available sources of motive power, including steam, electricity, forces of nature, compressed air, and the gas engine. 2500 w. Tradesman—May 1, 1897. No. 12577, 15 cts.

SHOP AND FOUNDRY.

BICYCLES.

Magnetic Chucks for Bicycle Work. Illustrated description of a device intended especially for chucking bicycle parts such as cups, cones, etc., while being ground after hardening. 500 w. Am Mach—April 29, 1897. No. 12546. 15 cts.

CASTING.

The Uehling Pig-Iron Casting Machine. Illustrated description of a machine invented by E. A. Uehling, which has stood the test of practical experience. 1100 w. Ir Age—April 22, 1897. No. 12300. 15 cts.

Hints on Castings Direct from the Blast-Furnace. W. H. Butlin. An investigation of some of the forces present in the production of castings run direct from the blast-furnace. 1600 w. Ir & Coal Trds Rev—April 2, 1897. No. 12154. 30 cts.

A New Method of Casting Pig-Iron. Illustrated description of a new apparatus recently designed by Edward A. Uehling, for casting and conveying pig iron at blast-furnaces. 1400 w. Eng News—April 29, 1897. No. 12530. 15 cts.

DRILLING.

Horizontal Drilling Machines. John Randol. Comments on the excellent work done by this tool and the causes of its rarity, with illustrated description of several machines. 1700 w. Am Mach—April 15, 1897. No. 12254. 15 cts.

ELECTRIC Power.

Recent Practice in the Application of Electricity to Engineering Tools. F. J. Rowan. Read before the Inst. of Engs. and Shipbuilders. Illustrations with a short record of results obtained with electro-magnetic machine tools. 1200

w. Ir & Coal Trd Rev—April 2, 1897. No. 12155. 30 cts.

GEARS.

Eccentric Gears. Frank Richards. Results of investigations of eccentric gears as employed for the quick return service. Diagram. 2000 w. Am Mach—April 22, 1897. No. 12294. 15 cts.

Gear Arm Proportions. Henry Hess. Formula and diagrams, with description of method. 1100 w. Am Mach—April 29, 1897. No. 12544. 15 cts.

On the Machine-Cutting of Accurate Bevel and Worm Gears. J. H. Gibson. Read before the Inst. of North-East Coast of Engs. & Shipbuilders. A brief illustrated description of two machines from the writer's designs, which have been satisfactorily worked for over a year, with notes on machine-cut gearing generally. 5400 w. Ind & Ir—March 26, and April 2, 1897. No. 12213. 30 cts.

KEY-FITTING.

Different Ways of Fitting a Key. John Randol. Illustrates and describes the process of fitting a key. 1200 w. Am Mach—April 29, 1897. No. 12543. 15 cts.

FOUNDRY.

Progress in the Iron Foundry. Dr. R. Moldenke. Read before the Pittsburg Foundrymen's Assn. Discusses scientific methods, cupola practice, power, equipment, cast sheets, and the iron. The subject is treated more from the engineering standpoint than from the chemical. 4800 w. Ir Trd Rev—April 29, 1897. No. 12532. 15 cts.

SCREW MACHINE.

The Spencer Double-Turret Automatic Screw Machine. Illustrated description. 1500 w. Am Mach—April 22, 1897. No. 12295. 15 cts.

STRESSES.

Safe Stresses for Stationary English Main-Shafts and Crosshead-pins as Deduced from the Records of Experience. Henry Hess. Records of experience giving data on the failures of various parts, with deductions. 600 w. Am Mach—April 8, 1897. No. 12119. 15. cts

TOOLS.

Pattern-Making Bench Tools. John M. Richardson. Confined to those tools which the workman can own. 2500 w. Am Mach—April 8, 1897. No. 12118. 15 cts.

See also Railroad Affairs, Maintenance of Equipment, for items relating to shop-work.

MISCELLANY.

AERONAUTICS.

Aeronautics in 1896. (Die Aëronautik im Jahre 1896.) A review of the progress made during the past year, with especial reference to Continental Europe. 3000 w. Zeitschr d. Oesterr Ing u. Arch Vereines—March 19, 1897. No. 12416. 30 cts.

BEAMS.

The Design of Beams. W. H. Atherton. Part first deals with engine beams, gun beams, cranes, bridge girders, shafts and sundry examples. Ill. 1700 w. Mech Wld—April 16, 1897. No. 12374. 30 cts.

BEARINGS.

Concerning Glass Machinery Bearings. F. A. Farnsworth. Illustrated description of experiments made. 1000 w. Ir Age—April 29, 1897. No. 12386. 15 cts.

CAM.

Pattern for a Cylinder Cam. John M. Richardson. Describes a cam for converting a rotary motion into a reciprocating one (within certain limits), and usually in a horizontal direction. Ill. 1300 w. Mach, N. Y.—May, 1897. No. 12571. 15 cts.

COLD.

Machine for the Production of Very Low Temperatures. (Machine zur Erzielung nildrigster Temperaturen, &c.) A communication by Prof. Linde of Munich, giving a full account of his apparatus for producing temperatures below —140° C. and for liquefaction of air. Two articles. 6000 w. Glaser's Annalen—March 15 & April 1, 1897. No. 12433. 30 cts. each.

CONDENSATION and Insulation.

Condensation in Steam Pipes and Insulating Materials. Dr. John Russner. Translated from Wochenblatt für Papierfabrikation. A study of the loss of heat from radiation and conduction, and the value of insulation. 2200 w. Power—May, 1897. No. 12559. 15 cts.

CYLINDERS.

Strength of Thick Hollow Cylinders. John H. Cooper. The work and results of many well-known writers arranged to exhibit the practical quality necessary to have if work is to be done. 2300 w. Prac Eng—March 26, 1897. No. 12065. 30 cts.

EDUCATION.

Industrial Education. George W. Dickie. The writer's experience of the kind of preparation necessary to fit one to fill an honorable place in the industrial army. Also discussion. 9000 w. Jour Assn of Engng Soc—March, 1897. No. 12512. 30 cts.

EXCAVATING.

The Calhoun Excavating and Conveying Machine. Illustrated description of a cableway device which has been used extensively in handling gravel, coal, and similar materials, and is now being built for sewer and ditch work. 1400 w. Eng News—April 15, 1897. No. 12205. 15 cts.

FORCING FITS.

Allowance for Forcing Fits. Reviews the prevailing practice as gathered from different makers, with tabulated statements. 1900 w. Mach, N. Y.—May, 1897. No. 12575. 15 cts.

INTERPOLATION.

Formulæ of Interpolation. Explains the Lagrange method of interpolation, as most generally applicable. 1400 w. Engng—March 26, 1897. No. 12068. 30 cts.

KITES.

I. Scientific Kite-Flying. J. B. Millett. II. Experiments with Kites. Hugh D. Wise. III. Photographing from Kites. William A. Eddy. Three illustrated articles. The first has special reference to the Blue Hill experiments; the second includes an account of the writer's ascent from Governor's Is.; the third includes accounts of the first photographing and

the first telephoning and telegraphing through a line held by kites. 12800 w. Cent Mag—May, 1897. No. 12518. 45 cts.

LUBRICANTS.

Notes on Liquid Lubricants. Henry E. Cutts. Some points on the selection of oils and their application. 1200 w. Marine Engng—April, 1897. No. 12108. 30 cts.

MACHINE Design.

Some Barriers to Progress in Machine Design. Charles Hotchkiss. A talk about designers and their relations to the business and the office of the work in which they may be engaged. 2500 w. Am Mach—April 29, 1897. No. 12545. 15 cts.

RUBBER Substitutes.

The Manufacture of Rubber Substitutes. Explains the term, and briefly considers the best known substitutes. 1100 w. Ind Rub Wld—April 10, 1897. No. 12384. 45 cts.

STRAINS.

On the Changes Produced in Soft Metals by Permanent Strain. Albert Campbell. Results of experiments to determine to what extent the properties of soft wires are affected by permanent strain, carried out on materials of widely different constitution. 2500 w. Engng—April 9, 1897. No 12226. 30 cts.

SUPERHEATER.

The Hering Steam Superheater. (Die Hering'schen Dampfüberhitzer.) Illustrated description of an improved apparatus giving better control over the temperature, and avoiding overheating. 2000 w. Oesterr Zeitschr f. Berg u. Hüttenwesen—Feb. 27, 1897. No. 12484. 30 cts.

TIE-RODS.

On the Arrangement and Computation of Tie-Rods in Condensers. Rudolph Leupold. The purpose of the article is to provide a rule for bracing by means of tie-rods, based on the principles of hydrostatics. 800 w. Pro Age—May 1, 1897. No. 12560. 15 cts.

TIRES.

Pneumatic Tires. Editorial discussion of rubber used, and processes it has to undergo before coming out as a finished tire. 1500 w. Engng—April 16, 1897. No. 12351. 30 cts.

WEIGHING Machine.

A Power-Feed, Automatic Weighing Machine. Illustrated description of a machine made by the Pratt & Whitney Co. of Hartford, Conn., and designed by Francis H. Richards. 2300 w. R R Gaz—April 16, 1897. No. 12210. 15 cts.

WIRE.

Wire. A. L. Orton. Methods of manufacture and the effect upon strength, conductivity, &c. 1800 w. Sib Jour of Engng—April, 1897. No. 12298. 30 cts.

MINING AND METALLURGY.

COAL AND COKE.

AYRSHIRE.

The Ayrshire Coalfield. M. E. The geology, method of working, ventilation, pumping, boilers, screening, &c. 1500 w. Col Guard—April 15, 1897. No. 12332. 30 cts.

BRIQUETTES.

The Briquette Works of the Senftenberg Soft Coal District. (Der Brikettfabriken des Senftenberger Braunkohlenreviers.) Report of a trip of investigation made by Prof. Scheele, and dealing mainly with the question of dust explosions in the course of the manufacture of coal briquettes. Two articles. 3500 w. Glückauf—March 13, 20, 1897. No. 12485. 30 cts. each.

Dust Explosions in Briquette Works and Means for Their Prevention. A. Scheele. From notes of a visit to the briquette factories of the Senftenberg lignite district. Concludes that collecting chambers are not necessary, discusses means of getting rid of the dust, &c. 4000 w. Col Guard—April 15, 1897. No. 12330. 30 cts.

COAL.

Ohio Coal and the Railroads. Editorial on the importance of the Ohio coal field from the railroad point of view, the present condition of the industry. 1400 w. R R Gaz—April 16, 1897. No. 12212. 15 cts.

COAL GETTING.

Coal-Getting by Machinery. Charles Latham. Report of lecture at the University College, Nottingham. Discusses the effect upon labor, number employed, wages, safety, &c. 1600 w. Col Guard—April 15, 1897. No. 12333. 30 cts.

COLORADO.

The Newcastle Mines. R. M. Hosea. One of the Colorado Fuel and Iron Co.'s most extensive coal mining plants is described and illustrated. The peculiar geological features of the coal measures, methods of working, drainage, ventilation, &c. 7200 w. Col Eng—April, 1897. Serial. 1st part. No. 12271. 30 cts.

EXPLOSIONS.

Saving Life in Colliery Explosions. Ernest J. Bailey. The writer's suggestions to meet life-saving requirements from afterdamp after explosions. A scheme for supplying fresh air by means of a compressed air plant. 1800 w. Col Guard—April 9, 1897. No. 12256. 30 cts.

FIREDAMP.

Contributions to the Firedamp Question (Beiträge zur Schlagwetterfrage.) An elaborate review of Behren's treatise, giving data relating especially to the coal mines of Austro-Hungary. Three articles, 8000 w. Oesterr. Zeitschr für Berg u. Hüttenwesen—Jan. 23, 30, Feb. 6, 1897. No. 12480. 30 cts. each.

HOCKING Valley.

Job's Mine, in the Hocking Valley, Ohio. Illustrates and describes the machines in use at this mine, which is one of the largest producers of bituminous coal in the United States. 800 w. Eng & Min Jour—April 17, 1897. No. 12263. 15 cts.

INCLINE.

New Arrangements of Brake Incline. From communications by Bergassessor Stens of Essen-an-der Ruhr, to Glückauf. The method of haulage is described and its advantages and dis-

advantages noted. Ill. 1800 w. Col Guard—April 2, 1897. No. 12164. 30 cts.

MINERAL Seams.

The Mineral Seams of New Monkland, Lanarkshire. James Prentice. Abstract of a paper read before the Mining Inst. of Scotland. Description of the seams which have been or are being worked, from which in recent years upwards to 1½ million tons annually have been raised. 3000 w. Col Guard—April 2, 1897. No. 12166. 30 cts.

MINING.

Steam, Compressed Air, and Electricity for Haulage, Coal-Cutting, &c. Ernest Kilburn Scott. Essay submitted in competition for special prize. A few of the points which should receive consideration when deciding what system of working is likely to give the greatest economy and the maximum amount of convenience. 3800 w. Ir & Coal Trds Rev—April 2, 1897. Serial. 1st part. No. 12153. 15 cts.

SOUTH AFRICA.

South African Coal. The steady development of coal-mining in the Cape of Good Hope and Natal as shown in the history of coal for the railways. 2000 w. Engng—April 9, 1897. No. 12225. 30 cts.

THIN Seams.

The winning of Thin Flat Coal Seams. (Abbau minder machtiger flachliegender Flotze.) Describing a system of long wall mining to obtain the coal with a minimum of waste. 3000 w. & 1 plate. Oesterr Zeitschr f. Berg. u. Hüttenwesen—Jan. 30, 1897. No. 12479. 30 cts.

WAGES.

Wages in the Coal Mining Industry during 1895. From the third annual report on changes in wages and hours of labor in the United Kingdom during 1895, by H. Llewellyn Smith of the Labor Dept. of the Board of Trade. 1200 w. Col. Guard—March 26, 1897. No. 12081. 30 cts.

COPPER.

COPPER Minerals.

The Occurrence of Copper Minerals in Hematite Ore, Montana Mine, Soudan, Minnesota. Part I, is a description of the occurrence, by J. H. Eby; and part II., a study of the minerals, by Charles P. Berkey. 5000 w. Pro L Sup Min Inst—Aug., 1896. No. 12505. 45 cts.

MICHIGAN.

Machinery of the Copper Mines of Michigan. Charles P. Paulding. Illustrated description. 1800 w. Am Mach—April 8, 1897. No. 12117. 15 cts.

GOLD AND SILVER.

AMALGAMATION.

Theories of Pan Amalgamation. E. Herligendorfer. Discovers the reason why raw pan amalgamation can never recover all the silver from sulphurets. 900 w. Min & Sci Pr—April 24, 1897. No. 12387. 15 cts.

CYANIDE PROCESS.

The Cyanide Process of Gold Extraction. An illustrated description of the nature of the process, its chemical principles, &c. 2200 w. Eng, Lond—April 16, 1897. Serial. 1st part. No. 12325. 30 cts.

EAST INDIES.

Gold in the Dutch East Indies. Reinier Verbeek. An interesting letter full of information of the conditions, people, climate, mines, &c. 2400 w. Eng & Min Jour—April 17, 1897. No. 12262. 15 cts.

GOLD.

Gold from the Sea and River. Discusses the probability of gold existing in this quarter, and the chemist's explanation of how it gets there. 1100 w. Mach—April 15, 1897. No. 12354. 30 cts.

GRAVEL DEPOSITS.

The Marble Belt. A. Thurston Heydon. A region of interest to miners because of the large deposits of rich gravel. Reviews the formation, character and past work. 1000 w. Min & Sci Pr—April 10, 1897. No. 12269 15 cts.

MASHONALAND.

Notes on the Umtali District (Manica Mashonaland) (Ein Beitrag zur Keuntniss deo Umtali Districts) (Manica Mashonaland) Geological notes on the Mashonaland gold district, with map and sections. 2500 w. and map. Oesterr Zeitschr f Berg u. Hüttenwesen—Jan. 2, 1897. No. 12477. 30 cts.

MILLING.

Some Notes on the Milling of Gold Ores. John E. Hardman. Outlines the most prominent conditions of ores met with in practice, and discusses the selecting of the process for milling and its importance, the design of the plant, &c. 4000 w. Can Min Rev—April, 1897. No. 12567. 30 cts.

NEW GUINEA.

The Gold Rush to British New Guinea. Theodore F. Bevan. A lecture delivered in Melbourne is reported, with the discussion that followed. 3000 w. Aust Min Stand—Feb. 18, 1897. No. 12146. 30 cts.

ONTARIO.

The Western Ontario Gold Fields and their Genesis. F. Hills. Considers the Bad Vermilion Lake and the Saw Bill Lake deposits, describing the formation and process of deposition. Ill. 5000 w. Can Min Rev—April, 1897. No. 12565. 30 cts.

PYRITIC Gold Ores.

Practical Treatment of Pyritic Gold Ores at Gibbonsville, Idaho. A detailed sketch of the reduction plant, and the methods of treatment employed therein. 3500 w. Min & Sci Pr—April 3, 1897. No. 12131. 15 cts.

SAN JUAN.

A Second Visit to the San Juan, Colorado, Region After Three Years' Absence. Arthur Lakes. Describes the crossing of San Luis park, recent eruptions of lava, great coal fields, visits to prominent ore mines, &c. 6800 w. Col Eng—April 1897, No. 12272. 30 cts.

SEPARATION.

Separation of Gold and Silver from Low-Grade Bullion. F. Gutzkow. Describes the writer's process of parting doré silver as adapted to the treatment of coppery silver bullion. 1700 w. Eng & Min Jour—April 17, 1897. No. 12264. 15 cts.

SIBERIA.

Gold Mining in Siberia. Russell L. Dunn. Gives conclusions from a study of Siberian mines and mining conditions on the ground, explaining methods of prospecting, exploration, &c.

Ill. 3000 w. Min & Sci Pr—April 3, 1897. No. 12130. 15 cts.

SOUTHERN UNITED STATES.

The Southern Gold Belt. William M. Bowron. The Gold mining in the South, with description of modern practice at the Royal gold-mine, Tallapoosa, Ga. Ill. 4000 w. Tradesman—May 1, 1897. No. 12576. 15 cts.

SULPHIDE Ores.

Silver-Lead-Zinc Sulphide Ores. J. T. Greenbury. Describes operations which represent very nearly what has been accomplished on a practical scale in connection with the treatment of the Broken Hill sulphide ores. 3000 w. Aust Min Stand—Jan. 20, 1897. No. 11626. 60 cts.

TAILINGS.

The Treatment of Tailings by the Cyanide Process. John Yates. A comparison of the zinc and electrical methods, with a short description of the plant and appliances required in each. 1900 w. Aust Min Stand—March 11, 1897. Serial. 1st part. No. 12181. 30 cts.

VICTORIA.

The Alluvial Leads of Victoria. Plan of these leads from the source to the present workings, with tabulated statement giving some idea of the metal won. 500 w. Aust Min Stand—Feb. 25, 1897. No. 12156. 30 cts.

YUKON District.

Gold Mining in the Yukon District. W. M. Ogilvie. Detailed description of the different methods of gold mining used, with information in regard to the various routes by which one may arrive at these gold fields, and points of interest to miners. 4400 w. Can Min Rev—April, 1897. No. 12569. 30 cts.

IRON AND STEEL.

ARMOR PLATE.

Trial of Side and Deck Armor for the United States Battleships Kearsarge and Kentucky. Engraving of test plate with particulars of test. 700 w. Sci Am—May 1, 1897. No. 12388. 15 cts.

Tests of Armor Plates at the Witkowitz Iron Works. (Schiessversuche gegen Panzerplatten im Eisenwerke Witkowitz.) Comparative tests of Harveyized and nickel-steel plates, both showing good results, rather favoring the latter. 2000 w. Stahl und Eisen—April 1, 1897. No. 12439. 30 cts.

The Armor Plate Imbroglio. W. L. C. A statement of the situation, with letters from the Illinois Steel Co., the Carnegie Steel Co., and the Bethlehem Iron Co., with suggestions from Secretary Long. 3800 w. Ir Age—April 15, 1897. No. 12199. 15 cts.

BIRMINGHAM, Alabama.

Notes on the Birmingham District. John S. Kennedy. Information as to improved practice and low cost of production. 2300 w. Ir Age—April 22, 1897. Serial. 1st part. No. 12299. 15 cts.

The Tennessee Company's Properties. A number of views and brief description of representative furnace plants and iron ore mines of the Birmingham district. 800 w. Ir Trd Rev—April 1, 1897. No. 12094. 15 cts.

BLAST Furnace.

American and British Blast-Furnace Practice. J. Stephen Jeans. Showing comparative labor costs in the United States and Europe. Second paper. 4400 w. Eng Mag—May, 1897. No. 12581. 30 cts.

CASTING.

See same title under Mechanical Engineering, Shop and Foundry.

CONCENTRATION.

The Magnetic Concentration of Iron Ores. (Elektromagnetische Aufbereitung der Eisenerze.) A general review of the progress made in Germany and America. 3500 w. Stahl und Eisen—March 15, 1897. No. 12436. 30 cts.

The Wetherell Magnetic Concentrating Process. H. B. C. Nitze. A process for separating various mineral and chemical substances, of such feeble magnetic permeability, that they have been heretofore generally considered as non-magnetic, from one another and from such accompaniments as are absolutely inert, by means of powerful and specially-devised electro-magnets. Ill. 3800 w. Jour Fr Inst—April, 1897. No. 12113. 45 cts.

DUQUESNE.

The Duquesne Furnaces of the Carnegie Steel Company, Limited. Illustrated interesting description of this new furnace plant. 3500 w. Ry Rev—April 3, 1897. No. 12079. 15 cts.

ELASTICITY.

Elasticity and Fatigue. H. K. Landis. Part first deals only with elasticity of steel, considering the elastic factors, methods of testing, drop of beam, permanent set, proportionality, comparison of limits and dynamic elasticity. 4200 w. Am Eng & R R Jour—May, 1897. Serial. 1st part. No. 12521. 30 cts.

HYDRAULIC PRESS.

The Steam Hydraulic Press as a Substitute for the Blooming Hammer. (Ersatz der Luppenhämmer durch dampf-hydraulische Pressen.) Description and illustration of combined steam and hydraulic press for handling blooms, instead of the steam hammer. 2500 w. Stahl und Eisen—April 1, 1897. No. 12438. 30 cts.

IRON Industry in India.

The Practicability of Establishing an Iron Industry at or near Salem (India). Comment on paper on this subject by Jeremiah Head. The report deals exhaustively with the subject and gives conclusions which finally pronounce the opinion that the work is not at present practicable. These conclusions are examined. 3000 w. Ind Engng—March 13, 1897. No. 12201. 45 cts.

IRON Range.

The Marquette Iron Range of Michigan. George A. Newett. Description of the district and mines, with map. Ill. 7700 w. Pro L Sup Min Inst—Aug., 1896. No. 12506. 45 cts.

NICKEL STEEL.

Nickel-Steel as an Improved Material for Boiler Shell Plates, Forgings, and Other Purposes. William Beardmore. Paper read before Inst. of Naval Archts. Showing reasons why, in the writer's opinion, nickel-steel is a most suitable material with which to meet the de-

mands for a metal stronger than steel. Ill. 2500 w. Ind & Iron—April 15, 1897. No. 12344. 30 cts.

The Expansion of Nickel-Steel. (Sur ladilatation des aciers au nickel.) A communication to the Académie des Sciences by M. Guillaume, giving coefficients of expansion for a number of different alloys of steel and nickel. 1000 w. Moniteur Industrielle—Feb. 13, 1897. No. 12490. 30 cts.

OPEN HEARTH.

The Bertrand Thiel Open Hearth Process. Joseph Hartshorne. Comments on the paper of P. C. Gilchrist on the above named process, with its discussion, with report on the work which is being done at present. 3500 w. Ir Age—April 15, 1897. No. 12197. 15 cts.

SAMPLING.

Methods of Sampling Iron Ore. C. T. Mixer. Presents the schemes adopted at some mines in Marquette County, to separate properly their various ores, with remarks on the occurrence of the iron and phosphorus in some of the deposits. 2300 w. Pro L Sup Min Inst—Aug., 1896. No. 12502. 45 cts.

STEEL.

Some Recent Views of Bridge and Boiler Steel. J. C. Some details of the present trend of thought and practice among American engineers. 1000 w. Ir & Coal Trds Rev—April 16, 1897. No. 12370. 30 cts.

Steel Processes. B. F. Spalding. Brief discussion of new processes, and opinions of metallurgists. 2800 w. Prac Eng—March 26, 1897. No. 12066. 30 cts.

STEEL Construction.

See same title under Architecture and Building, Construction and Design.

SULPHUR.

The Occurrence of Sulphur in Iron. Its Introduction and Removal. E. L. Rhead. Read before the West of Scotland Iron and Steel Inst. The paper proposes to deal mainly with a mass of evidence accumulated by many workers, and as far as possible reduce it to order. 2200 w. Am Mfr & Ir Wld—April 2, 1897. Serial. 1st part. No. 12083. 15 cts.

MINING.

BRACING.

Comparative Tests of Bracing for Wooden Bents. Edgar Kidwell. Describes a series of experiments made to obtain data as to the relative value of the different forms of bracing with conclusions Ill. 5000 w. Pro L Sup Min Inst—Aug., 1896. No. 12503. 45 cts.

CO-OWNERSHIP.

The Law as to the Co-ownership of Mining Property. Discusses the subject from the English point of view. 2300 w. Col Guard—April 15, 1897. No. 12334. 30 cts.

FREEZING.

Sinking Shafts by Freezing Process. (Fonçage des Puits de Mine par Congélation.) Describes the natural process, the Poetsch system as used in France, also the systems of Gobert and Koch, and the cold air method of Lindmarck, used in Sweden. 3000 w. 1 plate. La Revue Technique—March 25, 1897. No. 12425. 45 cts.

HAULAGE.

I. Electric Mine Haulage Plant. E. F. Bradt. II. Underground Electric Haulage Plant. James E. Jopling. The first paper describes the plant of the Pittsburg and Lake Angeline Iron Co., Mich., and the second the plant in the Cleveland Lake Mine, Ishpeming, Mich., with discussion of both papers. 4000 w. Pro L Sup Min Inst—Aug., 1896. No. 12501. 45 cts.

HYDRAULIC Mining.

Practical Notes on Hydraulic Mining. George H. Evans. Part first names points on which a mine manager should be thoroughly posted, and considers water facilities, and nature of the country for grades, etc., as the first two. 2000 w. Min & Sci Pr—April 10, 1897. Serial. 1st part. No. 12268. 15 cts.

HOISTS.

Electric Hoists for Mines. Illustrated description of several hoists which have have been in constant service for months. 1000 w. Ir Trd Rev—April 1, 1897. No. 12095. 15 cts.

MINE Shots.

Electric Ignition of Mine Shots. Bergassessor Heise. From a report in "Glückauf," of a lecture to the Assn. of Technical Mine Managers for the Dortmund District. Discusses heat ignition, spark ignition, safety in firedamp, &c. 1600 w. Col Guard—March 20, 1897. No. 12082. 30 cts.

MINING Machinery.

A Few Notes on Material used in Mining Machinery. H. W. De Courteney. Dissects the stamp mill into its principal parts, and discusses the metal which is best suited to each part. The various qualities of iron and steel as adapted to the use. 3800 w. Can Min Rev—April, 1897. No. 12568. 30 cts.

PACIFIC Coast.

Electricity in Mining on the Pacific Coast. F. A. C. Perrine. Statements showing the unsuitability of electrical mining apparatus to the particular conditions of the mines on the Pacific slope. 1400 w. Elec Engng—April 15, 1897. No. 12232. 15 cts.

PETROLEUM.

The Petroleum Industry in Russia. (Die Erdölindustrie in Russland.) A general review of the official Russian report made for the Nijni-Novgorod Exposition, giving data from 1882 to 1895 inclusive; chiefly statistical. Two articles. 7000 w. Oesterr-Zeitschr f. Berg u. Hüttenwesen—Jan. 16-23, 1897. No. 12478. 30 cts. each.

PUMPS.

Mine Pumps. Philip R. Bjorling. Part first consists of introductory remarks and a description of the action of an ordinary bucket pump. Ill. 600 w. Mech Wld—March 26, 1897. Serial. 1st part. No. 12057. 30 cts.

STEAM SHOVEL.

The Steam Shovel in Mining. A. W. Robinson. Considers briefly the design and construction of the steam shovel, and the considerations which should govern the selection of a shovel to suit the work of the mining regions. 3800 w. Pro L Sup Min Inst—Aug., 1896. No. 12504. 45 cts.

WINDING.

New Winding Arrangment with Constant Resistance. André Després. Describes a new method whose object is to afford an absolutely constant movement with a single chain, to permit of employing the lightest possible chain, to afford a high degree of safety, &c. 2400 w. Col Guard—April 9, 1897. No. 12257. 30 cts.

MISCELLANY.

ALLOYS.

Alloys. Prof. Roberts-Austen. Report of second Cantor lecture on this subject. 1200 w. Engng—March 26, 1897. No. 12071. 30 cts.

Alloys. Prof. Roberts-Austen. Report of his third Cantor lecture on this subject. 900 w. Engng—April 2, 1897. No. 12162. 30 cts.

Alloys. Prof. Roberts-Austen. Report of the fourth and concluding Cantor lecture on this subject, taking up the discussion of curves of initial freezing points. 600 w. Engng—April 9, 1897. No. 12229. 30 cts.

ALUMINUM.

Aluminum and Its Use in the Foundry. Joseph Allison Steinmetz. General advantages claimed with general conclusions. 2000 w. Ir Age—April 15, 1897. No. 12198. 15 cts.

Aluminum: Its Present and Future. Part first reviews early investigation of this metal, and the processes used. 2500 w. Eng, Lond—April 2, 1897. No. 12148. 30 cts.

The Working of Sheet Aluminum. From "The Aluminum World" The great secret is said to consist in the proper lubricant and the shape of the tool. Discusses lathe work, drawing, spinning, frosting and burnishing. 2300 w. Ir Age—April 29, 1897. No. 12385. 15 cts.

CARBON.

Contributions to the Investigation of the Crystallization of Carbon. (Beiträge zur Keuntnis der für die Krystallization des Kohlenstoffes Günstigen Bedingungen.) A paper by Dr. Borchers describing his own experiments with a special form of electric furnace, and indicating the lines on which further experiments should be continued. 3000 w. Zeitschr für Elektrochemie—March 20, 1897. No. 12452. 30 cts.

DIAMONDS.

The Diamond Mines of Kimberley. Dr. William Crookes. Two lectures delivered at the Imperial Inst. Interesting description of Kimberley, the mines, workings, &c. 6800 w. Nature—April 1, 1897. No. 12167. 30 cts.

EXPOSITION.

Notes from the Millennial Exposition. (Von der Millenniums-Landesausstellung.) Giving an account of the exhibits relating to the mining industry; chiefly mechanical. 1000 w. 1 plate. Oesterr Zeitschr f. Berg u. Hüttenwesen—Feb. 13, 1897. No. 12481. 30 cts.

GYPSUM.

Gypsum in Kansas. G. P. Grimsley. Early account of this mineral, and the location, geology, topography, &c., of the areas in this state. Ill. 4500 w. Kansas Univ Quar—Jan., 1897. No. 12127. 45 cts.

On the Chemical Composition of Some Kansas Gypsum Rocks. E. H. S. Bailey and W. M. Whitten. The results of analysis of average samples of the rock or dirt used at the mills. 1500 w. Kansas Univ Quar—Jan., 1897. No. 12128. 45 cts.

LEASE.

Specific Performance of Contracts for Lease of Mines. The essential facts of the decisions in the cases relating thereto which have come before the High and Appeal Courts of England for adjudication. Also a statement of the principles which guide these courts in directing and refusing specific performance of contracts 3000 w. Col Guard—April 2, 1897. No. 12165. 30 cts.

MICA.

A New Use for Scrap Mica. H. C. Mitchell. Read before the Ontario Min. Inst. Showing that this hitherto costly waste may become a valuable by-product. Describes its manufacture as an insulator of steam heat, its use for fireproofing, its use in resisting extreme cold, &c. 3000 w. Can Min Rev—April, 1897. No. 12566. 30 cts.

SALT.

The Müller Salt Press. (Ueber die Müller'sche Salzbriquettes-Presse.) An illustrated description of the apparatus used in Austria for compressing salt into "briquettes" for commercial convenience. Two articles and 1 plate. 6000 w. Oester Zeitschr f. Berg u. Hüttenwesen—March 13, 20, 1897. No. 12483. 30 cts. each.

THERMOPHONE.

Wiborgh's Thermophone. (J. Wiborgh's Thermophone.) The thermophone consists of an explosive pellet embedded in a cylinder of fire-clay. The time elapsing from the exposure to heat to the explosion is a measure of the temperature. 3500 w. Oesterr Zeitschr f. Berg. u. Hüttenwesen—Feb. 20, 1897. No. 12482. 30 cts.

TUYERES.

Making Tuyeres—Bronze or Copper. Phil. Pastre. Illustrated description. 800 w. Mach, N. Y.—May, 1897. No. 12573. 15 cts.

UTAH.

The Camp Floyd Mining District and the Mercur Mines, Utah. R. C. Gemmell. Part first gives the history and topography of this district, fifty miles south of Salt Lake City. Ill. 2000 w. Eng and Min Jour—April 24, 1897. Serial. 1st part. No. 12347. 15 cts.

MUNICIPAL ENGINEERING.

GAS SUPPLY.

ACETYLENE.

Acetylene and its Liability to Explosion. (Das Acetylen und Seine Explosions gefährlichkeit.) A paper by Dr. Slaby before the Society of Railway Engineers, showing that with reasonable care, explosions need not occur. 2000 w. Glaser's Annalen—April 1, 1897. No. 12434. 45 cts.

Acetylene on Board Ships. Vivian B. Lewes. Report of a lecture delivered before the Inst. of

Naval Arch'ts. Considers the uses to which it could be put, and the factor of danger. 1200 w. Gas Wld—April 10, 1897. No. 12252. 30 cts.

Acetylene Solution. (L'Acétylène Dissous) A proposition to dissolve acetylene gas in liquid acetone, the latter being obtained by calcination of acetate of lime. The gas in solution under pressure to be served to customers in siphons similar to those used for carbonated waters. 1000 w. La Revue Technique—March 25, 1897. No. 12430. 45 cts.

Further Communications on Acetylene. (Einige weitere Mittheilungen über Acetylen.) A paper and discussion by Inspector Leissner and others before the German Society of Mechanical Engineers, including the apparatus for the production of the carbide of calcium, and the reduction of cost and danger. 7500 w. Glaser's Annalen—March 15, 1897. No. 12431. 45 cts.

German Chemists Discuss Acetylene. Report of discussion of the Berlin Chemical Industrial Society. 1500 w. Gas Wld—April 3, 1897. No. 12160. 30 cts.

Letang & Serpollet's Acetylene Lamp. A. Etançon, in La Nature. Illustrated description of the lamp, manner of charging and cost of light. 1200 w. Sci Am Sup—May 1, 1897. No. 12400. 15 cts.

The Future of Acetylene. Interesting evidence given by Thomas Holliday, chemist and engineer, before a select committee of the House of Commons, in support of the Irish Industries Bill, and advocating Ireland as a center for this industry. 2200 w. Gas Wld—April 17, 1897. No. 12336. 30 cts.

EXTINGUISHING.

New System for the Instantaneous Lighting and Extinguishing of Gas Jets at Any Distance. Translated from Le Gaz, by Herman Poole. Explains the system devised jointly by Mr. Egraz, Doctor Guyenot, and Mr. Chateau. The power used is electricity. 2000 w. Am Gas Lgt Jour—April 26, 1897. No. 12342. 15 cts.

COAL GAS.

The Commercial Uses of Coal Gas. Thomas Fletcher. These notes are the result of more than thirty years' experience as to the practical working, results, advantages, and drawbacks, of coal-gas as a fuel. 3000 w. Gas Wld—April 8, 1897. No. 12159. 30 cts.

COST.

Some Notes of the Comparative Cost of Supplying Light by Gas and Electricity in Manchester. G. E. Stevenson. The question is confined to the cost of supply. In manufacturing, gas shows but little advantage over electricity, but in distribution there is a decided difference in favor of gas. 1800 w. Gas Eng's Mag—April 10, 1897. No. 12592. 30 cts.

GAS.

The Gas in Your House. Some useful things that the consumer ought to know. Burners, meters, variation of pressure, use of globes, &c. 2300 w. Dom Engng—April, 1897. No. 12368. 30 cts.

LEAKS.

The Detection of Leaks in Gas-Mains. Describes and approves the system of M. Bouvier, giving two examples where its use made a considerable saving. 2000 w. Jour Gas Lgt—April 6, 1897. No. 12253. 30 cts.

"MANJAK."

The Use of "Manjak" in the Manufacture of Coal Gas. Jos. Harger Pye. Remarks on the natural bituminous pitch which in the Barbados is known by the name of "Manjak." General characteristics and results obtained from its use. 1100 w. Jour Gas Lgt—April 20, 1897. No. 12525. 30 cts.

WATER GAS.

Prof. Lewes on Carburetted Water Gas. Report to Birkenhead with reference to the safety, or otherwise, of supplying a mixture of coal gas and carburetted water gas, and also as to the relative value of such a mixture as compared with coal gas of equal illuminating power. The present paper gives the experimental data and reasons upon which his conclusions are based. 2800 w. Gas Wld—April 17, 1897. No. 12335. 30 cts.

Observations on Carbureted Water Gas. J. T. Westcott. A paper prepared at the invitation of the Civil and Mechanical Engineers' Society of London, Eng. Gives the history, method of operation, analysis, cost, advantages, &c. 4800 w. Am. Gas Lgt Jour—April 12, 1897. No. 12182. 15 cts.

SEWERAGE.

DRAINAGE.

The Jourdan Avenue Drainage Station, New Orleans, La. Don Y. Dyer. The peculiar topography necessitated the raising of the surface drainage from receiving basins by the use of the pumps, over and outside the levees surrounding the city. The plant is described. 1100 w. Fire & Water—April 10, 1897. No. 12174. 15 cts.

SANITATION.

The Conversion of Discharges into Poudrette. (Die Verwandlung der Faeces in Poudrette.) A paper read by Dr. Vogel before the German Association for Sanitary Promotion, describing the chemical treatment by which night soil is converted into an inoffensive fertilizer. 3500 w. Gesundheits Ingenieur—March 15, 1897. No. 12447. 30 cts.

SEWAGE Plant.

The Sewage Disposal Plant at Central Falls, R. I. W. F. Keene. Illustrated description. 1000 w. Eng Rec—April 24, 1897. No. 12338. 15 cts.

SEWAGE Purification.

Purification of Sewage (Klärversuche). A discussion of the Permanganate and Ferozone-Polarite Systems of purifying sewage water. 4000 w. 1 plate. Gesundheits-Ingenieur—Jan. 15, 1897. No. 12449. 30 cts.

VENTILATION.

Sewer Ventilation. Report of the Sanitary Committee of Cardiff. A tabulated statement of replies received from various towns as to certain points in connection with the subject. 1300 w. Plumb & Dec—April 1, 1897. No. 12202. 30 cts.

STREETS AND PAVEMENTS.

ASPHALT.

Asphalt and Asphalt Pavements. George W.

Tillson. Describes asphalt from various localities, and its use for pavements, with the questions related. 8800 w. Pro Am Soc of Civ Engs—April, 1897. No. 12515. $1.00.

Origin and History of Asphalt. Bernard Bienenfeld. Reviews the ancient uses and enduring qualities of this substance, its chemical mixture, and the probable origin. 3400 w. Munic Engng—May, 1897. No. 12556. 30 cts.

STREET CLEANING.

The Street Cleaning of Berlin. (Das stadtische Strassenreinigungswesen Berlins.) An account of the methods and cost of cleaning the streets of Berlin, in which it is shown that the per capita cost is only one-sixth that of New York. 2000 w. Gesundheits-Ingenieur—Feb. 28, 1897. No. 12445. 30 cts.

STREETS.

The Influence of Beautiful Streets upon Public Health. Considers the questions involved in modern street construction, and the numerous matters that must be provided for, and the importance of securing street engineers of true worth. 1100 w. San Rec—April 16, 1897. No. 12359. 30 cts.

WATER SUPPLY.

DISCHARGE Tunnels.

Discharge Tunnels from Reservoirs. James A. Paskin. Read before the British Assn. of Water-works Engs. at Nottingham. Consideration of important features in the construction of these outlets. 1600 w. Eng Rec—April 17, 1897. No. 12219. 15 cts.

ELECTRIC Pumps.

Waterworks with Electric Driving. (Wasserwerk mit elecktriktrischem Antrieb.) Illustrated description of the plant at Dillingen, Bavaria. A high-service system, the pressure being regulated by accumulators controlling the electric motors. The double-acting pumps have mechanically operated vaives. 1500 w. Zeitsch d. Vereines deutscher Ingenieure—March 20, 1897. No. 12406. 30 cts.

FINANCES.

The Financial Management of Water-Works. E. Kuichling. A discussion of the administrative policy. 7000 w. Pro Am Soc of Civ Eng—April, 1897. No. 12516. $1.00.

GREATER NEW YORK.

The New Charter and the Water Supply. An abstract of the provisions relating to this subject. 800 w. Fire & Water—April 24, 1897. Serial. 1st part. No. 12361. 15 cts.

HIGH Buildings.

New System of Water Supply for High Buildings. W. S. Huyette. Illustrated description of the pressure system as installed in the Union Trust Building, Detroit, Mich. 800 w. Heat & Ven—April 15, 1897. No. 12243. 15 cts.

NEW BEDFORD.

The Further Water Supply of the City of New Bedford, Now Being Constructed. Edmund Wood. A rapid review of the work dwelling only on those things which may be of more especial interest. Also discussion. 7800 w. Jour N E Water Assn—March, 1897. No. 12124. 75 cts.

POLLUTION.

The Protection of Surface Waters from Pollution. W. T. Sedgwick. A review of the various sources from which the water supply may receive pollution, with discussion. 8500 w. Jour N E Water Wks Assn—March, 1897. No. 12126. 75 cts.

PUMPING.

Deep Well Pumping. E. E. Johnson. Discusses from an engineering and practical standpoint, the various types and kinds of pumping machinery applied to this service. Illustrations and discussions. 18800 w. Jour of W Soc of Engs—April, 1897. No. 12399. 45 cts.

Pumping Engines. Arthur J. L. Loretz. A survey of the subject with the conclusion that the lifting process is far preferable to forcing. Discussion. 7500 w. Jour N E Water Wks Assn—March, 1897. No. 12125. 75 cts.

RESERVOIR.

The Trenton Reservoir. Illustrated description of a large storage reservoir now in process of construction, which will have a capacity of 104,000,000 gallons, and cost nearly $350,000. 1200 w. Eng Rec—April 3, 1897. No. 12086. 15 cts.

SOUTH Australia.

Water Supply in South Australia. A brief account of the schemes for the supply of towns, and references to irrigation schemes proposed. 1200 w. Engng—April 23, 1897. No. 12562. 30 cts.

WATER Tower.

The Waterworks of Calbe. (Das Wasserwerk der Stadt Calbe.) A description of the water works of a small town in Germany, of interest because of the Béton tank in the water tower, constructed on the Monier System. 3500 w. Zeitschr d. Vereines Deutscher Ingenieure—March 13, 1897. No. 12404. 30 cts.

WATER-WORKS.

Khandwa Water-Works. L. M. St. Clair. History of the present town supply, quantity of water available, and schemes proposed for its improvement, with description of new works to be opened. Map. 4200 w. Ind Engng—March 27, 1897. Serial. 1st part. No. 12542. 45 cts.

Number and Ownership of Water-Works in the United States and Canada. Tabulated statements giving number and ownership and number of towns supplied, with other information; and remarks on the improvement in the standard of living, &c., by the introduction of a public water supply. 2800 w. Eng News—April 29, 1897. No. 12528. 15 cts.

Present Tendencies in Water-Works Practice. Editorial based upon information contained in the 1897 "Manual of American Water-Works." Calls attention to the new things since the publication of the last "Manual," discusses waters, pipes, and gives general review of notable tendencies. 2200 w. Eng News—April 15, 1897. No. 12206. 15 cts.

WELLS.

Driven Wells at Brookline, Mass. F. F. Forbes. Describes the principal details of construction of work done under the writer's direction, to increase the water supply of the town. Discussion. 2300 w. Jour of the N E Water Wks Assn—March, 1897. No. 12123. 75 cts.

COAL PRODUCTION.

The Production of Coal: Its Consumption and Cost. Presents the objections to the estimate of the consumption of coal per capita, and discusses the production of the different countries, and the cost of producing. 2000 w. Engng—March 26, 1897. No. 12070. 30 cts.

MISCELLANY.

DISINFECTION.

The Disinfecting Oven of Vaillard & Besson. (Der Disinfektions ofen von Vaillard & Besson.) A convenient portable steam apparatus for disinfecting clothing and bedding, especially adapted for military use. 1500 w. Gesundheits Ingenieur—Feb. 15, 1897. No. 12442. 30 cts.

The Epidemic Hospital at Brünn. (Die Epidemie-Spital in Brünn.) An account of the disinfecting apparatus, used in connection with the heating and drying plant, whereby a considerable economy is effected, and thorough sterilization insured. 2500 w. 1 plate. Gesundheits-Ingenieur—Feb. 28, 1897. No. 12444. 30 cts.

GLASGOW.

The Story of Municipal Glasgow. Review of a recent volume by Sir James Bell, very complimentary to the author. 2800 w. Jour Gas Lgt—March 30, 1897. No. 12147. 30 cts.

NEW YORK.

The Greater New York. Franklin Matthews. Justification of the project, with statistics, improvements under way, government and general discussion. Ill. 3000 w. Harper's Wk—April 17, 1897. No. 12193. 15 cts.

SANITATION.

Hygienic Demands for School Buildings. A. M. Sloan. Read at meeting of the State Health Authorities at Harrisburg. Discusses the need of intelligent consideration of the conditions, gives general rules, and requirements in the ventilation and heating. 4000 w. San—April, 1897. No. 12055. 45 cts.

RAILROAD AFFAIRS.

NEW CONSTRUCTION.

COLUMBUS, O.

New Union Station at Columbus, O. Floor plans of building now in process of erection, with description. 1100 w. R R Gaz—April 30, 1897. No. 12536. 15 cts.

EXTENSION.

The National Docks & New Jersey Junction Connecting Railway. Map showing route and connections of an extension which, it is expected, will have the effect of considerably increasing the business and make possible a reduction in time and expense. 900 w. R R Gaz—April 9, 1897. No. 12138. 15 cts.

MANCHURIA.

The Projected Railway through Manchuria. (Die projectirte Eisenbahn durch die Mandschurei.) An account of the proposed diversion of the eastern section of the Trans-Siberian Railway through Chinese territory, with map. 1500 w. Zeitschd d. Oesterr Ing u. Arch Vereines—March 19, 1897. No. 12415. 30 cts.

NEW ZEALAND.

Railway Construction in New Zealand. The standard specification used for co-operative contracts in government railways. 2000 w. Arch Lond—April 16, 1897. No. 12356. 30 cts.

RACK RAILWAY.

The Combined Adhesion and Rack Railway between Beirut and Damascus. (Combinirte Adhäsious und Zahnradbahn, Beirut-Damaskus.) A very complete account of this interesting road, with topographical map, illustrations of construction, locomotives, &c. The Abt system is used for the steep grades. 10000 w. Mitt d. ver f. d. Forderung d. Lokal & Strassenbahnwesers—Jan., 1897. No. 12448. 45 cts.

MAINTENANCE OF EQUIPMENT.

AIR GAGE.

Best Location for the Air Gage Where it Can be Seen by Night and Day. Extracts from a report of a committee of the Air-Brake-Men's Assn., critcizing and suggesting in regard to the importance in location of air gage. 2000 w. R R Gaz—April 30, 1897. No. 12537. 15 cts.

AUSTRIA.

Notes on the Austrian Railroads. John R. Slack. About half the roads are owned by the state and the tendency is toward the acquisition of the remaining roads. Illustrated description of standard type of locomotive. 1000 w. R R Gaz—April 9, 1897. No. 12141. 15 cts.

AXLES.

Tests of a Wrought-Iron Car Axle. W. F. M. Goss. Describes and illustrates recent test of a 60,000-pound axle made in the Engineering Laboratory of Purdue University. 1100 w. Pamphlet. No. 12588. 45 cts.

BRAKE GEAR.

Foundation Brake Gear for Locomotive Tenders. Extracts from report of committee of the Air-Brake Men's Assn. Considers brake power, piston travel, brakebeams, &c. 2200 w. RR Gaz—April 30, 1897. No. 12540. 15 cts.

CAR LIGHTING.

The Lighting of Railway Cars. (Eisenbahn-Waggon-Beleuchtung.) A paper by H. Gerdes, the chief engineer of the Pintsch establishment, making comparisons between oil, gas, electricity, and acetylene for car lighting. 5000 w. Glaser's Annalen—April 1, 1897. No. 12435. 45 cts.

CAR WHEELS.

Transverse Strength of Chilled Car Wheel Metal as Affected by the Relative Directions of Stress and Chill, with Some Notes on the Chemistry of Cast Iron. Asa W. Whitney. A study of the peculiarities of cast iron, and the phenomena due to the relations of stress and chill, Ill. 4000 w. Jour Fr Inst—April, 1897. No. 12112. 45 cts.

COUPLER.

A Car Coupler Decision. The decision rendered by Judge Taft in the case of the St. Louis

Car Coupler Co. against the National Malleable Castings Co. in favor of the latter. 1500 w. RR Gaz—April 9, 1897. No. 12140. 15 cts.

COUPLER.

An important Coupler Patent Decision. Decision of Judge Taft, with illustrations of various patents. 3400 w. Ry Rev—April 10, 1897. No. 12177. 15 cts.

JUNGFRAU.

The Track Construction of the Jungfrau Rack Railway. (Der Oberban der Jungfraubahn.) With especial details of the Strub system of rack construction especially designed for this Alpine road. 3000 w. Schweizerische Bauzeitung—April 3, 1897. No. 12411. 30 cts.

LOCOMOTIVE.

Locomotive for Japan Railway Company. General description with illustration. 700 w. Loc Eng—April, 1897. No. 12084. 30 cts.

Japanese Locomotives. A supplement sheet containing the illustrations of all the locomotives used on the Japanese railways under the superintendence of Mr. Trevithick, with tabular statement of dimensions. 3200 w. Eng, Lond—March 26, 1897. No. 12100. 30 cts.

Mogul Locomotive for the Imperial Railways of Japan—Rogers Locomotive Company. Engravings showing one of 18 locomotives recently built for this road. The principal dimensions are given. 700 w. RR Gaz—April 9, 1897. No. 12139. 15 cts.

The New Heilmann Electric Locomotive. Description with illustration. 1100 w. Elec Rev—April 21, 1897. No. 12284. 15 cts.

The Evolution of the American Locomotive. Herbert T. Walker. An attempt to trace the progress from the machine of ninety years ago to the engine of modern times. Ill. 2800 w. Sci Am Sup—April 24, 1897. Serial. 1st part. No. 12290. 15 cts.

MAIN-ROD Stresses.

A Method of Calculating the Greatest Stresses in Certain Main Rods When Used on Locomotives. George H. Goodell. Mathematical discussion. 1500 w. RR Gaz—April 16, 1897. No. 12209. 15 cts.

METAL TRUCK.

The Kindl Metal Truck for 100000 Pounds Capacity Cars. Truck designed by F. H. Kindl. Illustrated description of the interesting features. 500 w. RR Gaz—April 23, 1897. No. 12304. 15 cts.

PRIVATE CAR.

Lincoln's Private Car. Illustrated description. 1200 w. RR Car Jour—April, 1897. No. 12186. 15 cts.

Modern Private Cars. Duane Doty. General remarks on progress, with illustrated description of the private car "Alexander." 2000 w. RR Car Jour—April, 1897. No. 12185. 15 cts.

Proposed Design for the Presidential Car. Archer Richards. Illustrated description. 700 w. RR Car Jour—April, 1897. No. 12187. 15 cts.

SHOPS.

The Michigan Central Shops at Jackson. A brief description of the plant, with drawings of a number of special tools. 2000 w. RR Gaz—April 23, 1897. No. 12307. 15 cts.

STAYBOLTS.

Notes on the Breaking of Staybolts. (Bemerkungen über Stehbolzenbruche.) An examination of the probable cause of the frequent breakage of staybolts in particular locations in locomotive fire boxes. 1500 w. Zeitschr d. Oesterr Ing u. Arch Vereines—March 19, 1897. No. 12414. 30 cts.

TIRES.

Devices in Use for Heating Tires in Shrinking On and Removal. Illustrates and describes a convenient arrangement for the use of gasoline for tire-heating purposes, in use at the Missouri Pacific shops at St. Louis. 450 w. Ry Age—April 30, 1897. No. 12553. 15 cts.

VALVES.

The Pressure-Retaining Valve and its Use. Extracts from report of a committee of the Air-Brakemen's Assn. The history of the introduction of the retaining-valve in the air-brake service, with recommendations. 2200 w. RR Gaz—April 30, 1897. No. 12539. 15 cts.

VENTILATION.

Car Ventilation. Investigation of the subject, as reported in the latest annual report of the Massachusetts Board of Railroad Commissioners. 3000 w. Ry Rev—April 10, 1897. No. 12175. 15 cts.

The Ventilation of Cars with Filtered Air. (Lüftungseinrichtung für Eisenbalmwagen mittelst filtrirter Luft.) Describes a simple air filter which has given good results on the Hannover State Railway. 4000 w. Glaser's Annalen—March 15, 1897. No. 12432. 45 cts.

MAINTENANCE OF WAY.

BRIDGES.

Railroad Bridges and Buildings. Walter G. Berg. General remarks with a brief survey of the leading characteristics of the various structures and classes of work. 2500 w. Railway Mag—March, 1897. No. 12116. 30 cts.

BUILDINGS.

Assam-Bengal Railway Head Office Buildings, Chittagong. Illustrated description. 800 w. Ind Engng—March 6, 1897. Serial. 1st part. No. 12183. 45 cts.

CURVES.

The Union of Parallel Tracks into a Single Given Curve. (Einführung von Parallelgeleisen in eine bestehende Kurve.) A graphical solution of a special problem in railroad curves. 1000 w. Schweizerische Bauzeitung—March 27, 1897. No. 12410. 30 cts.

TRACKS.

Railroad Track Experiments. From the report of the Tests of Metals and Other Materials at the United States Testing Plant at Watertown, Mass., for the year 1895. Experiments and results, with editorial. Ill. 2900 w. Ry Rev—May 1, 1897. No. 12557. 15 cts.

TREE CULTURE.

Tree Culture by Railways. D. C. Burson. Comments on the prospect of a fuel and lumber famine, and calls attention to what could be accomplished by growing timber on vacant, unimproved right of way lands, and recommends the planting of the catalpa speciosa. 1800 w. Ry Age—April 2, 1897. No. 12063. 15 cts.

WASHOUT.

A Remarkable and Costly Washout. Brief account of the accident on the Evansville and Terre Haute railroad, near Hazleton, Ind. Diagram. 500 w. Ry Age—April 2, 1897. No. 12062. 15 cts.

SIGNALING.

INTERLOCKING.

Indiana State Law Regulating the Interlocking of Railway Grade Crossings. Abstract of the main provisions of a law just passed. 1000 w. Eng News—April 29, 1897. No. 12529. 15 cts.

Interlocking Plant, Dolton, Ill. Illustrated description of the largest interlocking plant in the United States. 900 w. Ry Rev—April 17, 1897. No. 12285. 15 cts.

TRANSPORTATION.

BRITISH RAILWAYS.

The Recent Prosperity of British Railways. William J. Stevens. Showing the extent and causes of the greater returns from British railway investments since June 1, 1895. 4400 w. Eng Mag—May, 1897. No. 12584. 30 cts.

EARNINGS.

Railway Earnings Still Improving. Tables of gross earnings for March, and of gross earnings and mileage for two years, with comments. 2500 w. Bradstreet's—April 10, 1897. No. 12143. 15 cts.

ELECTRICAL Haulage.

The Electrical Haulage System of the New Orleans & Western Railroad Company at Port Chalmette, New Orleans, La. W. Nelson Smith. Interesting installation, recently completed, showing the adaptability of electricity to the conditions of a railroad yard. Ill. 2500 w. Elec Wld—April 3, 1897. No. 12090. 15 cts.

GRAIN Transportation.

Russian Grain Transportation. Editorial comment on lately published statistics of the production and movement of grain. 1500 w. RR Gaz—April 23, 1897. No. 12308. 15 cts.

M. C. B. RULES.

M. C. B. Rules. The revision of the Master Car Builders' rules of interchange as recommended by the Southern & Southwestern Ry Club. 1100 w. RR Gaz—April 23, 1897. No. 12306. 15 cts.

PASSENGER Rates.

On Two Cents Per Mile Passenger Rates. Extracts from address of James Charlton before the Senate Committee and House Committee on Railroads, Illinois legislature, opposing the proposed reduced rates. 2700 w. RR Gaz—April 30, 1897. No. 12541. 15 cts.

POOLING.

The Foraker Bill. Full text of the new senate bill for the legalization of railway pooling, with editorial. 2800 w. Ry Age—April 9, 1897. No. 12152. 15 cts.

TRANS-MISSOURI Decision.

See same title under Economics and Industry. Governmental Control.

RAILROAD Law.

South Dakota Railroad Law. Summary of the provisions of the act passed by the last legislature, to regulate common carriers, etc. 1800 w. RR Gaz—April 30, 1897. No. 12535. 15 cts.

TRANSPORTATION.

Cheap Transportation in the United States. J. A. Latcha. Favoring transportation by railroad, and considering briefly canal transportation, which the writer thinks has in general passed the era of its usefulness. The requisites for improvement are discussed. 6000 w. N Am Rev—May, 1897. No. 12510. 45 cts.

The Relation of Railroads and Localities. A. J. Vanlandingham. From an address before the Commercial Club of Kansas City. A discussion of rates and related questions. 1200 w. Ry Rev—April 10, 1897. No. 12176. 15 cts.

MISCELLANY.

ACCIDENTS.

Train Accidents in the United States in March. Classified statement of accidents of the month with summary. 2500 w. RR Gaz—April 23, 1897. No. 12305. 15 cts.

ACCOUNTING.

Motive Power Accounting. W. G. Taylor. Reviews the most important features, and the importance of accuracy in details, &c. 3000 w. Railway Mag—March, 1897. No. 12115. 30 cts.

ASIA.

A Visit to Russian Central Asia. Michael Francis O'Dwyer. An interesting, descriptive paper, containing information concerning the Transcaspian railway. Also discussion. Ill. 25000 w. Jour Soc of Arts—April 16, 1897. No. 12235. 30 cts.

CHINA.

Opportunities for American Engineers and Railway Builders in China. R. Van Bergen. Showing that the conditions are favorable for business in this field. 800 w. Eng News—April 29, 1897. No. 12527. 15 cts.

Railway Development in the Celestial Empire. Information of proposed undertakings, their routes, and the effect looked for on the country. 2000 w. Trans—April 16, 1897. No. 12372. 30 cts.

Railway Prospects in China. Considers the interests and influence of Russia in this field, also the other forces at work. 2200 w. Engng—March 26, 1897. No. 12069. 30 cts.

COMPRESSED AIR.

The Uses of Compressed Air on Railways. J. H. McConnell. Calls attention to the many uses in train service and shop, and the large extent to which it has replaced hand labor and steam. 1400 w. Railway Mag—March, 1897. No. 12114. 30 cts.

CURVES.

Transition Curves. Letters from various correspondence bearing on this subject. 2500 w. Eng News—April 15, 1897. No. 12207. 15 cts.

ELECTRIC Traction.

See same title under Street and Electric Railways.

ELECTRICITY.

The Application of Electricity to Railway Working. Review of a book by W. E. Langdon, superintendent and engineer of the electrical department of the Midland Railway. 2000 w. Trans—March 26, 1897. No. 12093. 30 cts.

MEXICO.
See same title under Economics and Industry. Miscellany.

PRUSSIA.
The Prussian State Railroads. Editorial on report recently issued recording the results from the new organization in force since April 1, 1895. 1350 w. RR Gaz—April 9, 1897. No. 12142. 15 cts.

RAILROAD Securities.
The Increased Confidence in American Railroad Securities. Thomas F. Woodlock. Showing that railroads should not, by the issue of long-term bonds, sacrifice advantages arising from future improvement in credit. 3200 w. Eng. Mag—May, 1897. No. 12578. 30 cts.

REFUNDING.
New York Central Refunding. A statement of the plan in brief. 500 w. Bradstreet's—April 17, 1897. No. 12217. 15 cts.

VENEZUELA.
Venezuela Railroad Development. Report of the Puerto Gabello & Valencia Railway, and the Great Venezuela Railway. A descriptive and historical sketch. 5500 w. Cons Reports—April, 1897. No. 12395. 45 cts.

STREET AND ELECTRIC RAILWAYS.

ACCOUNTANTS.
Papers Read at the Convention of Street Railway Accountants at Cleveland, March 23–24. Papers by H. L. Wilson, P. V. Burington, J. P. E. Clark, W. B. Brockway, Frank R. Greene, Dana Stevens, and C. N. Duffy on subjects of interest to accountants. 11500 w. St Ry Jour—April, 1897. No. 12075. 45 cts.

ACCUMULATORS.
Accumulator Tramways. (Ueber Akkumulatorenbahnen.) A paper before the Electrotechnical Society of Cologne, dealing mainly with the commercial results of the use of storage batteries on various German tramways. 5000 w. Elektrotechnische Zeitschr—April 1, 1897. No. 12470. 30 cts.

BUDAPEST.
The Budapest Underground Electric Railway. Illustrated description of this subway which has been working some months with success. 2500 w. Ry Wld—April, 1897. No. 12265. 30 cts.

CAR MOTORS.
Controlling the Speed of Car Motors. William Baxter, Jr. An explanation of the methods used. 1800 w. Elec Wld—April 10, 1897. Serial. 1st part. No. 12172. 15 cts.

CHICAGO.
The Suburban Railroad Company, Chicago. Illustrated description of construction with other information. 1800 w. St Ry Rev—April 15, 1897. No. 12258. 30 cts.

COMPRESSED AIR.
Compressed Air for Street Railway Service. Experience. A criticism of General Haupt's assertions as published in the N. Y. Sun. 1200 w. Elec Rev, Lond—April 7, 1897. No. 12106. 15 cts.
See also title "Compressed Air" under Railroad affairs. Miscellany.

CONDUITS.
Feeder-Conduit Construction. N. S. Hill, Jr. Extract from report made by the Electrical Commission of the city of Baltimore. The different styles of conduits and methods of ventilating them. 1600. St Ry Jour—May, 1897. No. 12550. 45 cts.
The "Simplex" Conduit Electric Tramway. Illustrated description of this inverted trolley system. 3000 w. Ry Wld—April, 1897. No. 12267. 30 cts.

CONSTRUCTION.
The System of the Canal & Claiborne Railroad Company. Illustrated detailed description. 10000 w. St Ry Jour—May, 1897. No. 12547. 45 cts.

ELECTRIC Railway.
Electric Railway Engineering. Alex. McCallum. The modifications required for British conditions. It is thought that the Board of Trade regulations will increase the initial cost by from 30 to 40 per cent. on long lines. 1600 w. St Ry Jour—April, 1897. No. 12077. 45 cts.
The Lorain and Cleveland Electric Railway. Illustrated detailed description of an inter-urban road recently constructed. 2000 w. St Ry Jour—April, 1897. No. 12076. 45 cts.

ELECTRIC Traction.
Electric Traction under Steam-Railway Conditions. Charles Henry Davis. Showing under what circumstances electric traction may be profitably substituted for steam locomotion. 4400 w. Eng Mag—May, 1897. No. 12579. 30 cts.
Direct-Coupled versus Belt-Driven Units for Electric Traction. Alfred H. Gibbings. Considers briefly the advantages of direct-coupled engines and dynamos as compared with those which are coupled by rope or belt gearing. 1500 w Ry Wld—April, 1897. Serial. 1st part. No. 12266. 30 cts.
Some Recent Developments in Electric-Traction Appliances. A. K. Baylor. Part first is a comparison of a modern traction generating plant with one of seven or eight years ago. Ill. 1300 w. Elec Eng. Lond—April 9, 1897. Serial. 1st part. No. 12251. 30 cts.

EUROPEAN Electric Roads.
Electric Railway Practice in Europe. The principal street railway systems of several European cities are described with special reference to the engineering methods adopted in the construction of their road bed, their overhead construction, their power stations and their rolling stock, and to the financial results which have so far come from the introduction of electricity. Also editorial. Ill. 12500 w. St Ry Jour—April, 1897. No. 12072. 45 cts.
Comparison of Street Railway Conditions and Methods in Europe and in the United States. P. F. Sullivan. Glasgow and Berlin are selected as typical cities, and comparison

made, showing fares to be actually higher, distance rates not advisable, and street railway investments more desirable. 9500 w. St Ry Rev —April 15, 1897. No. 12259. 30 cts.

GENERATORS.

Connections of Railway Generators. J. E. Woodbridge. Describes the plan of a proposed system, stating its advantages. 700 w. Elec Wld—April 17, 1897. No. 12279 15 cts.

GREECE.

Street and Other Railways in Greece. Nicholas D. Sourmely. Thinks it a good field for American contractors, locomotive, and rolling-stock builders to transact business. 1200 w. St Ry Jour—April, 1897. No. 12078. 45 cts.

HAMBURG.

The Introduction of Electric Power on the Hamburg-Altona Central Tramway. (Die Einführung des Elektrischen Betriebes bei der Hamburg-Altonaer Zentralbahn.) Illustrated description of an important overhead trolley line, with details of motors, switchboard, &c. 3500 w. Zeitschr d. Vereines Deutscher Ingenieure —March 6, 1897. No. 12402. 30 cts.

HANNOVER.

The Hannover Electric Tramway. (Die Elektrische Strassenbahn in Hannover.) A description of the tests and performance of a combined overhead trolley and accumulator system. The accumulators serve not only to propel the cars through the central portion of the city, but also act to equalize the demands upon the generators. A valuable paper. 7500 w. Elektrotechnische Zeitschr—April 1, 1897. No. 12467. 30 cts.

HUMPHREY Bill.

The Real Question in the Humphrey Bill. A bill for the protection of street-railway companies, which recently passed the Illinois senate is explained. 1000 w. Ry Age—April 23, 1897. No. 12343. 15 cts.

ILLINOIS.

Street Railways of Illinois and Their Franchise Conditions. Abstract of statement made by the presidents of several of the principal Chicago street railway lines, in reference to the growth of the street railways in this country, their relation to the growth of cities, and on the demand for lower fares. 6000 w. St Ry Jour —May, 1897. No. 12552. 45 cts.

ITALY.

Street and Steam Railways in Italy. F. Benedetti. Considers mainly the lines propelled by steam, and discusses their relation to modern life as shown in Italy. 2000 w. Chau—May, 1897. No. 12358. 30 cts.

OPERATION.

Stopping Another Leak in Electric Railway Operation. J. R. Cravath. Illustrated description of recorder, with tests, and the benefits from its use. 3000 w. St Ry Rev—April 15, 1897. No. 12260. 30 cts.

POWER Station.

Power Station Controversy in Chicago. An abstract of the reports of Messrs. Peirce, Richardson & Foster, and R. J. Hill on the Chicago city plants, after critical examination. 6000 w. St Ry Jour—May, 1897. No. 12548. 45 cts.

RAIL JOINTS.

The Construction of Rail Joints. Alfred Birk. Extract from an article published in the Bulletin of the International Railway Congress. Illustrates and discusses the various kinds of joints, and draws conclusions from the investigations. 3500 w. St Ry Jour—May, 1897. No. 12551. 45 cts.

RAPID Transit.

Notes on Rapid Transit. W. L. Derr. Full paper with appendix and discussion. Ill. 31000 w. N Y R R Club—March 18, 1897. No. 12222. 45 cts.

Requirements of High Speed and Heavy Electric Traction. Hayward Cochrane and E. J. Swartout. The paper aims to present the practical conclusions of the best authorities and to suggest outlines of what the writers consider to be the best results obtainable from the use of electrical machinery as now manufactured. Read before the Chicago Elec. Assn. Ill. 3500 w. W Elect'n—May 1, 1897. No. 12522. 15 cts.

The Reno Rapid-Transit Plan for Broadway, New York. J. W. Reno. An article aiming to show that an economical rapid transit system may be constructed at a cost of construction not above $35,000,000. Ill. 1300 w. Sci Am Sup —April 24, 1897. No. 12291. 15 cts.

STREET Railways.

An Informal Talk on Financial Practice and Engineering Methods of American Street Railways. E. E. Higgins. Delivered before the New York Electrical Soc. at Columbia College. Part first explains why the street railway section of the country is necessarily in the east, gives a brief historical review, and discusses franchises and burdens. 2300 w. Elec —April 14, 1897. Serial. 1st part. No. 12195. 15 cts.

TESTS.

Important Electric Railroad Tests. Brief illustrated account of tests made by the General Electric Co. on its own special line of track at Schenectady, N. Y. 1000 w. Ir Trd Rev— April 8, 1897. No. 12133. 15 cts.

TRACKS.

New Track Construction in Pittsburg. Description with extracts from specifications. 1300 w. St Ry Jour—May, 1897. No. 12549. 45 cts.

TRAMWAYS.

Modern Electric Tramway Systems. (Neuere Systeme Elektrischer Bahnen.) A paper before the electrotechnical society of Cologne, discussing overhead and underground trolley systems, as well as the combination of overhead wire and accumulators. 3500 w. Elektrotechnische Zeitschr—March 25, 1897. No. 12466. 30 cts.

TROLLEY.

Sliding vs. Rolling Contact for Electric Tramways. (Ueber Bügel-und Rollen-Kontakt be Elektrischen Strassenbahnen.) Showing that with a properly constructed sliding contact there is less wear on the conducting wire than with the roller, owing to the action of the sides of the grooves in the trolley roller. 2000 w. Deutsche Zestschr für Elektrotecknik—March, 1897. No. 12457. 30 cts.

TROLLEY Servitudes.

The Connecticut Decision on Trolley Servitudes. Editorial on the decision of the Connecticut Supreme Court that an electric railroad in a street is not necessarily an additional servitude, entitling the adjacent land owner to damages. 1300 w. RR Gaz—April 16, 1897 No. 12211. 15 cts.

BOOKS OF THE MONTH

Adams Patent Sewage Lift Co., London, Eng. Sewer-Flushing Diagrams for Engineers, Surveyors, etc. Spon & Chamberlain, New York; E. and F. N. Spon, London. Printed on stiff boards, without cover. Price, $5.

These diagrams are intended for, and will be effective in, saving labor in calculating the value of any given flush upon a sewer. The diagrams are made from actual readings—surface velocities—taken as from manhole to manhole, but averaged in cases of extreme irregularity, as through blockage or unusually faulty construction. Full explanations of the use of the diagrams are given, and from them can be seen how far the discharge from a flush-tank will give a self-cleansing velocity.

Spalding, Frederick P., assistant professor of engineering at Cornell University. Hydraulic Cement; Its Properties, Testing, and Use. John Wiley & Sons, New York. 1897. Cloth. Price, $2.

The results of careful study are embodied in this book, and the various tests for cements are discussed. Prof. Spalding gives free expression to his own opinions. The results of investigations carried out in Europe, and the recommendations of commissions appointed in Europe, form an important part of the treatise. Sample specifications are appended to the final chapter, which treats of cement, mortar, and concrete. In the present confused condition of opinion regarding the testing of cement, this work will be a guide to the best current practice.

Suplee, Henry Harrison, B. Sc., member of American Society of Mechanical Engineers, and of the Franklin Institute. Mathematics Self-Taught: The Lübsen Method for Self-Instruction and Use in the Practical Problems of Life. I. Arithmetic and Algebra. Adapted from the German of H. B. Lübsen. Published by the author, West Chelten Avenue, Philadelphia, Pa.

Mr. Suplee states in his preface that this is an effort to place before English-speaking students a treatise on arithmetic and algebra, freed from technicalities and expressed in simple language, which "will assist many who are compelled to study alone." He also thinks "it may not be unwelcome to some who wish to 'brush up' their rusty mathematical information, acquired long years ago under scholastic methods and not improved by years of disuse." A very cursory examination of the pages of the volume will convince mathematicians that the effort to do this has succeeded. The volume translated by Mr. Suplee has passed through twenty-seven editions in German, which sufficiently indicates its repute in German-speaking countries. But Mr. Suplee has done more than translate; he has added, edited, and adapted, to meet the wants of English-speaking students. The additions consist chiefly of Prof. Robinson's method of approximating roots, examples for practice, and Walenn's method of verifying the accuracy of products by "imitation." We heartily commend this book to all who seek the aid it is intended to supply.

Johnson, Prof. J. B., C. E. The Materials of Construction. A Treatise for Engineers on the Strength of Engineering Materials. First Edition. John Wiley & Sons, New York. 1897. Cloth, $6.

The author is professor of civil engineering in Washington University, St. Louis, Mo., and ranks high, both as practical engineer and instructor. He is a member of many of the most prominent engineering societies, among which is the International Association for the Standardizing of Methods of Testing Materials. The fact of this latter membership is alone a sufficient warrant of his eminent fitness to prepare the treatise, the name of the publishing firm being also a warrant of excellence in printing and illustration. As chairman of the board of managers of the Association of Engineering Societies, Professor Johnson was editor of the index of engineering literature which appeared for some four years in the *Journal* of the Association of Engineering Societies, and which is now merged in the "Engineering Index," regularly published by THE ENGINEERING MAGAZINE. The book now under discussion is, in our opinion, destined to become at once a standard authority among engineers and architects. Prof. Johnson has given to the engineering profession a book which will long rank as a leading authority. The work is divided into four parts:

I. Synopsis of the Principles of Mechanics underlying the Laws of the Strength of Materials. II. Manufacture and General Properties of the Materials of Construction. III. The Methods of Testing the Strength of Materials. IV. The Mechanical Properties of Materials of Construction as Determined by Actual Tests. It is a handsome octavo of 787 pages.

Allen, C. F., Associate Professor of Railroad Engineering, Massachusetts Institute of Technology. Tables for Earthwork Computation. Published by the Author. Boston, Mass. 1893. Cloth, $1.50.

By the aid of these tables the labor of earthwork computation may be very much simplified and lessened. Table I is for sections of any base or slope, irregular as well as regular. Table II gives readily results correct by the prismoidal formula. Provision is made in Table III for very rapidly taking out quantities for level sections, when the center heights alone are given; a limited number of the most common bases and slopes are also provided for. Great accuracy is claimed. The author will be thankful to be informed of any error that may be discovered.

Edward B. Smith & Co., New York. The Application of Paints, Varnishes, and Enamels for the Protection of Iron and Steel Structures and Hydraulic Work. Third Edition, enlarged.

This may be fairly described as an invaluable text-book upon the subjects indicated. It consists in the main of papers read by Mr. A. H. Sabin before the American Society of Civil Engineers, and other technical organizations of high standing, and, though it is issued free of charge, it contains but one page of advertising, and it should find a place in every engineer's library.

BOOKS ANNOUNCED.

Ebert, H. Magnetic Fields of Force. An Exposition of the Phenomena of Magnetism, Electro-Magnetism, and Induction Based on the Conception of Lines of Force. Translated by C. V. Burton. Part 1. Longmans, Green & Co. New York, 1897. Cloth, $3.50.

Van Ornum, J. L. Topographical Surveys. Their Methods and Value. University of Wisconsin. Madison, Wis. 1897. Paper, 35c.

Cottage Designs, with Constructive Details by various architects. A Practical Book for Builders and Those Intending to Build. D. Williams. 1897. Paper, $1.

Kellog, Day Otis, D. D. Editor. New American Supplement to the Latest Edition of The Encyclopedia Britannica. The Werner Company, New York and Chicago. 1897. Cloth (subs.), $3.

Butterfield, W. J. Atkinson. The Chemistry of Gas Manufacture. A Handbook on the Production, Purification, and Testing of Illuminating Gas, and Assay of By-Products of Gas Manufacture. Imported by J. B. Lippincott Co., Philadelphia. 1896. Cloth, $3.50.

Carter, E. Tremlett. Motive Power and Gearing for Electrical Machinery. A Treatise on the Theory and Practice of the Mechanical Equipment of Power Stations for Electrical Supply and for Electric Traction. D. Van Nostrand Company. 1897. Cloth, $5.

Dodsworth, Walter. The Commercial Year-Book. A Statistical Annual Relating to the Commerce, Industries, Agriculture, Banking, Currencies, Investments, Railroads, Shipping, Insurance, Population, etc., of the United States and Foreign Countries. The *Journal of Commerce* and Commercial Bulletin, 1897. Cloth, $1.50.

Donkin, Bryan, Jr. Gas, Oil, and Air Engines. Practical Text-Book on Internal Combustion. Motors without Boilers. Second edition, revised and enlarged. J. B. Lippincott Co., Philadelphia. 1897. Cloth, $7.50.

Levasseur, E. The Concentration of Industry and Machinery in the United States. American Academy of Political and Social Science, Philadelphia. 1897. Paper, 25 cts.

Rideal, S. Water and its Purification. A Hand-Book for the Use of Local Authorities, Sanitary Officers, and Others Interested in Water-Supply. Imported by J. B. Lippincott Co., Philadelphia. 1897. Cloth, $2.50.

Mackenzie, T. Practical Mechanics Applied to the Requirements of the Sailor. J. B. Lippincott Co. 1897. Cloth, $1.50.

Anderson, W. J. The Architecture of the Renaissance in Italy. A General View for the Use of Students and Others. Imported by C. Scribner's Sons. 1897. Cloth, $5.

O'Donahue, T. A. Colliery Surveying: A Primer Designed for The Use of Students and Colliery Manager Aspirants. The Macmillan Co., New York. 1897.

Phillips, Jos. Wood Carving, Being a Carefully Graduated Educational Course for Schools and Adult Classes. Imported by C. Scribner's Sons, New York. 1897. Cloth, $1.

Wilson, H. M. Manual of Irrigation Engineering. Second edition, revised and enlarged. J. Wiley & Sons, New York. 1897. Cloth, $4.

Woollcombe, W. Practical Work in Physics for Use in Schools and Colleges. Part 3.—Light and Sound. The Macmillan Co., New York. 1897. Cloth, 90c.

Ames, Jos. S. Theory of Physics. Harper, New York. 1897. Cloth, $1.60.

Anthony, W. A., and Brackett, Cyrus F. Elementary Text-Book of Physics. New edition revised by W. F. Magie. J. Wiley & Sons, New York. 1897.

NEW CATALOGUES AND TRADE PUBLICATIONS.

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Montgomery & Co., New York.=(a) An important and voluminous tool catalogue for 1897. Royal octavo of 710 pages, bound in stiff buckram covers. An illustrated price-list of supplies, tools, and machinery for all mechanical trades. (b) Discount sheet to accompany this catalogue. The lines listed are very extensive and comprehensive.

The Ingersoll-Sergeant Drill Co., New York. =Pamphlet entitled "Water Pumped by Compressed Air," illustrating and describing the Pohle air-lift pump system, explaining the principles upon which it does its work, setting forth the conditions for obtaining highest efficiency, and showing the superior advantages and economy of this system for pumping water in many situations and under various conditions. It also describes and illustrates air compressors found best adapted to this kind of service and explains different methods of piping artesian wells, and a method of regulating flow. In addition there is an enumeration of various places and water works where the system is used, and where it is giving great satisfaction, as indicated by numerous testimonials.

The J. M. Carpenter Tap and Die Co., Pawtucket, R. I., U. S. A.=Catalogue No. 11 B., illustrating and describing a list of goods manufactured for bicycle work.

Ramapo Iron Works, Hillburn, Rockland Co., N. Y., U. S. A.=Illustrated catalogue of switches and frogs for railways.

Link Belt Machinery Co., Chicago, U. S. A., New Orleans, La., U. S. A.=Illustrated and beautifully-printed pamphlet entitled "Modern Methods, as Applied to the Coaling of Locomotives, the Handling of Freight in Warehouses and Wharves, and the Storage of Coal." The modern methods here spoken of are those introduced by this company.

National Lead Co., New York.=Pamphlet, "Why and How to Use Red Lead," to secure simplicity, certainty, and permanence. A refutation of attacks upon the use of red lead, by parties interested in the manufacture of other paints.

Royal Electric Company, Peoria, Ill., U. S. A.=Pamphlet, "Facts Worth Considering and of Interest to You." A collection of letters from users of the "Royal" Alternator, testifying to its simplicity, efficiency, and durability.

The Q. & C. Company, Chicago, U. S. A.= (a) Illustrated and beautifully-printed pamphlet, describing the "McKee Brake Slack Adjuster." (b) Leaflet, illustrating and describing the "Williams" portable stay-bolt drilling machine.

Joseph Dixon Crucible Co., Jersey City, N. J., =Pamphlet describing a long line of Dixon's graphite productions manufactured only by this company.

Dietz, Schumacher & Boye, Cincinnati, Ohio. =Catalogue of the line of machine tools manufactured by this firm.

S. Morgan Smith Co., York, Pa., U. S. A.= Descriptive, illustrated catalogue of the McCormick Turbine, manufactured by this company, with appended tables of data.

Thomas Carlin's Sons, Allegheny, Pa., U. S. A. =Eighth Illustrated Catalogue of engines, boilers, brick plant and hoisting machinery, city and park sewer castings, etc.; 229 pages octavo, cloth binding.

Johnson & Phillips, Victoria Works, Old Charlton, Kent, and Union Court, Old Broad Street, London, E. C.=Sheet No. 3, containing eighteen engravings of cable-making and wire-covering machinery, with accompanying descriptions of each on separate sheets fastened together.

Lehigh Valley Railroad, Philadelphia, Pa.= First number of a new illustrated quarterly issued by this company under the name, "*Black Diamond Express*," and devoted to the business and business interests of the road. It is a handsomely-printed and an interesting publication.

Davis & Egan, Cincinnati, Ohio, U. S. A. New York. Chicago. St. Louis. Boston. Philadelphia.=Elegantly-printed and illustrated quarto catalogue of a long line of machine tools manufactured by this company, successors to the Lodge & Davis Tool Co.

Blackmer & Post Pipe Co., St. Louis, Mo., U. S. A.=Illustrated pamphlet entitled "Something about Culvert Pipe," which describes the vitrified pipes made by this company, beginning with the material and its preparation, and sets forth at length, for the information of railroad men and engineers in general, the uses of this pipe and the relation it bears to railroad construction, special mention being made of "Double Strength" pipe extensevely used by railway and construction companies.

Jeffrey Manufacturing Co., Columbus, Ohio, U. S. A. (Branches at New York and Denver).= Elegantly-printed and illustrated descriptive catalogue of chain belting, steel cable, elevating and conveying machinery, elevators, and conveyors, carriers, labor-saving appliances, power-transmission machinery, mill, factory and mine supplies, coal-washing and mining machinery.

The Electric Storage Battery Company, Philadelphia, Pa., U. S. A.=Catalogue A, 10th edition. Illustrates and describes a line of "chlorid" accumulators, and enumerates the various uses to which these accumulators can be economically and advantageously applied. Also includes a series of specifications of accumulators of different sizes, with prices.

American Impulse Wheel Company, of New York.=Illustrated pamphlet, (stiff covers) describing the "Perfect American Hurdy Gurdy," and considering its principles of construction and operation in the light of modern hydraulics.

The conditions of maximum efficiency are considered, and the symbols and equations for the computation of values in the estimation and survey of water-power are presented both in the foot-pound system, and in the metric system, with an explanation of their use. A table of pressure-equivalents, horse-power, quantity of water, and number of revolutions under heads of from nine to two thousand feet, computed and arranged by F. M. F. Cazin, (inventor of the "Cazin Standard-Wheels" manufactured by this company), is embodied in the pamphlet, and a table of equivalents of units of energy and work is appended.

C. M. Giddings, M. E., Rockford, Ill., U. S. A.=(*a*) Circular illustrating and describing Giddings "Universal" valve-movement model (four models in one) to illustrate Corliss valve gear, single or double D-valves, siding cut-off valves, double-ported slide, and piston valves. (*b*) Circular (with blue-print samples) of sets of working drawings of steam engines supplied by Mr. Giddings, (ten different sizes). (*c*) Circular illustrating and describing the Giddings' "Commercial" automatic governor.

Cincinnati Screw and Tap Co., Cincinnati, Ohio, U. S. A.=(*a*) Leaflet,—description of Howe's special tool steel, and price-list of "Decimal" polished-steel drill-rods. (*b*) Leaflet,—price-list of taps, dies, screws, nuts, etc.

Buhl Stamping Co., Detroit, Mich., U. S. A. =(*a*) Pamphlet illustrating and describing a line of lanterns manufactured by this company. (*b*) Circular illustrating and describing cans for milk, etc., comprising description of the "Buhl Rustless" can, etc.

Globe Chuck Co., Washington, D. C., U. S. A.=Illustrated catalogue and price-list of Globe Chucks.

James L. Robertson & Sons, successors to Hine & Robertson Co., New York=Illustrated pamphlet describing steam indicators, gage-testing apparatus, etc.

R. M. Clough, New Haven, Conn., U. S. A. =Catalogue and price-lists of gear and milling cutters and small tools.

Norton Emery Wheel Co., Worcester, Mass., U. S. A.=(a) Pamphlet illustrating and describing the Bath indicator for testing the truth and alignment of machine parts. (b) Illustrated catalogue of emery goods and grinding machinery.

American Steam Gage Co., Boston, New York, and Chicago=Illustrated descriptive catalogue of gages, etc.

Philadelphia Engineering Works, Limited, Philadelphia, Pa.=Illustrated pamphlet describing the Philadelphia water-tube safety boiler, with dimension tables and other data; and calling attention to condensers, air-pumps, feed-water heaters, steel-plate chimneys, and gas and air compressors manufactured by the same establishment.

Clayton & Lambert Mfg. Co., Ypsilanti, Mich., U. S. A.=Pamphlet entitled "Gasoline Fires and Hose Fittings." Illustrates and describes not only gasoline fires, but also a number of devices pertaining to the rubber-hose trade.

Taylor, Wilson & Co., Limited, Allegheny, Pa., U. S. A.="Hand Book of Gearing." Formulæ and tables relating to transmission of power by gearing and belting, accompanied by a catalogue of the manufactures of this company, inclusive of pipe-mill machinery, foundry equipment, water-works and gasoline connections, gas producers, etc., etc.

The Quaker City Electric Company, Philadelphia, Pa., U. S. A.=Descriptive and illustrated catalogue of dynamo-electric machinery for light and power.

Blackner & Post Pipe Co., St. Louis, Mo., U. S. A.=Pamphlet entitled "Vitrified Pipe vs. Brick Sewers." Illustrates and describes vitrified standard culvert and sewer pipe thirty inches in diameter, and sets forth its superiority to brick sewers.

The Pennock Electric Co., New York=Pamphlet treating of the inventions and improvement in the field of electricity attributed to Mr. Geo. B. Pennock, the president and general manager of the company.

Betts Machine Company, Wilmington, Delaware, U. S. A.=Pamphlet illustrating and describing extension boring and turning mills manufactured by this company.

Reynolds & Co., New Haven, Conn., U.S.A. =(*a*) Catalogue illustrating and describing molding machines for metal castings. (*b*) Price list of set, cap, and machine screws, machine bolts, and coach screws.

Hobson & Company, Tatany, Pa., U.S.A.= Illustrated catalogue of tip-carts, two-wheel timber trucks, express and contractor's wagons, etc.

Edwin Harrington, Son & Co., Philadelphia, New York.= (*a*) Pamphlet entitled "Pointer No. 2, 1896." Illustrates and describes a line of elevators and dumb waiters. (*b*) Pamphlet illustrating and describing hoists, tramways, and traveling cranes.

Nagle Engine & Boiler Works, Erie, Pa., U. S.A.=Catalogue of portable, stationary, agricultural, and vertical steam engines and boilers, gasoline engines and the "Ennes" tubular well machine.

Tower & Lyon, New York.=No. 10 illustrated catalogue of hardware specialties, fine tools, and police equipments: including also goods of the Union Hardware Co., such as skates, dog-collars, gun implements, wood goods, tackle blocks, etc.: Also goods of the International Glue Co.,—"Martin's" liquid fish glue, belting cement, "Mystic" glue, etc.

Milne Manufacturing Co,, Monmouth, Illinois, U. S. A.=(*a*) Annual catalogue illustrating and describing "Hawkeye" grub and stump machine, the "Iron Giant" grub and stump machine and "I. X. L." grubber. Milne's patent wire-rope cutter, and Milne's rope hook. (*b*) Leaflet illustrating and describing the "Victoria" tilting clothes reel.

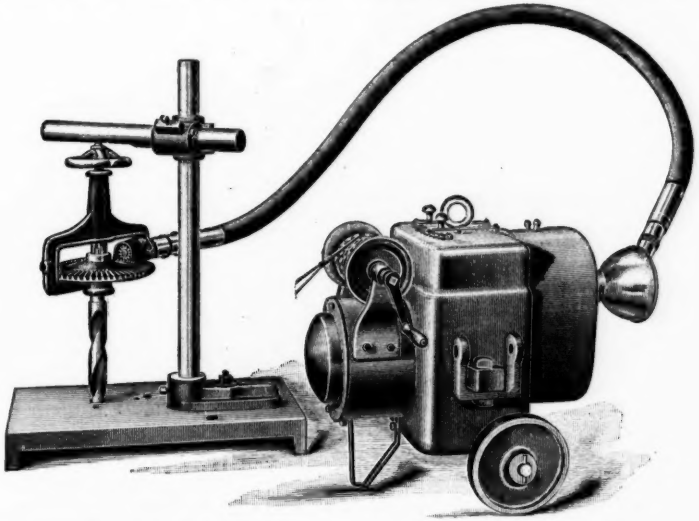
IMPROVED MACHINERY

NEW PROCESSES. NEW APPLIANCES.

The matter published in this department is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

The "Stow" Flexible Shaft and "Iron Clad" Electric Motor.

THIS combination of the "Stow" flexible shaft with the new "Iron Clad" electric motor, designed and manufactured by the Stow Manufacturing Company, Binghamton, N. Y., as adapted to drilling, tapping, seaming, etc., is well illustrated in the accompanying engraving, which tells its own story so far as the application is concerned. The motor, however, requires more detailed mention. The combination of an electric motor with a flexible shaft for the performance of this class of work, has been in use for some years, and, in the main, has given good satisfaction. There yet remained, however, some improvements needed to bring this combination to practical perfection as voiced in the demand which has sprung up for a dust- and water-proof motor which this new "Iron clad" motor has been designed to meet. The frame of this motor is in the form of a hollow cube with inwardly-projecting poles. In each end of the frame is a circular aperture, over which is bolted the end plates supporting the bearings. One of these is extended into a short cylinder forming a case for the commutator and brush holder. The field coils are protected by metallic cases and can be easily removed. The motors below 2 H. P. are bipolar and those of 2 H. P. and over have four poles. The best of material is used in construction. Self-oiling bearings; mica insulation; rheostats protected by iron case; gears covered and, by simply changing the end plates, to bring the oil chambers below the bearings, this motor can be run in almost any position. Motors of this type can be furnished for direct connection when desired, also for electric street-railway track drilling. The portable motors, as shown, are fitted with truck wheels, leg, eye bolt, side brackets, reel, twenty yards of insulated wire, and one set of reduction gears. By use of speed regulator and gears, almost any practical speed can be obtained. Either the company or their European Agents, Messrs. Selig, Sonnenthal & Co., 85 Queen Victoria St., London, E. C., may be addressed for prices or for further information.



A New Pipe-Threading Machine.

THIS machine was designed to respond to frequent calls for a machine threading from ¼ to 2 inch pipe, and its designers, The Armstrong Manufacturing Company, 139 Center street, New York, claim to have turned out a superior tool for this purpose.

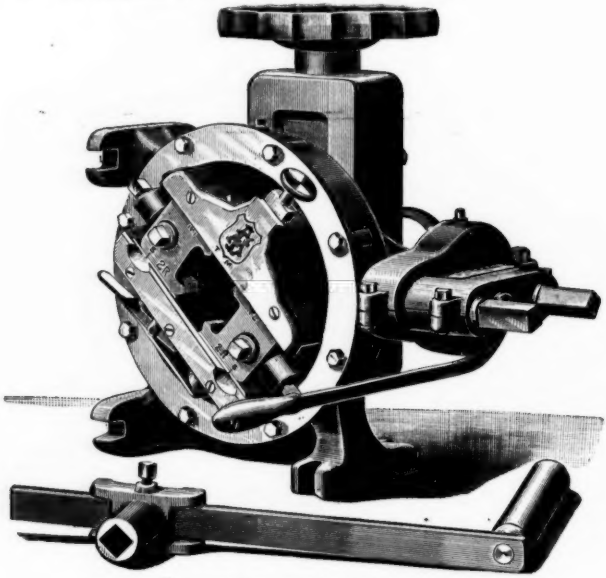
The machine uses the well-known regular Armstrong adjustable dies which are put in the machine and adjusted in the same manner as in the hand stock, and which can be opened for removing the pipe after cutting a thread and then locked back to the standard size without resetting. The dies, in this machine can be adjusted, however, to the variations of the fittings, the same as in the hand stock. All the gears and moving parts run in oil enclosed in a chamber covering and protecting them from chips and dust. The machine is thus self-oiling in all its parts, oil being put in through two holes provided with screw plugs.

It is impossible for the die-head to get loose, a common occurrence with some makes of pipe-threading machines. An inner journal increases the wearing surface of the bearings of the die-carrying head. A very powerful self-centering vise, exerting its power from the center of the jaws and not on the side, holds the pipe while being threaded.

The machine may be adjusted to a post on the side of a building, or on a bench, which is a new and special feature of this tool.

The machine has two speeds, a change from one to the other being effected by merely removing the crank from one spindle to the other. This enables the operator to cut from ⅛″ to 1″ pipe inclusive with great rapidity, and then by changing to the other speed, he can cut from 1¼″ to 2″ inclusive.

The machine can be furnished with dies for threading pipe from ⅛″ to 2″, either right or left, or with bolt dies for threading from ½″ to 1½″ rod, inclusive, also with dies for threading brass tubing.



NO. "O" ARMSTRONG PIPE-THREADING MACHINE.

This new pipe-threading machine attracted much attention at the Gas Exposition recently held in Madison Square Garden, N. Y. City. The Armstrong Manufacturing Company may also be addressed at its factory in Bridgeport, Conn.

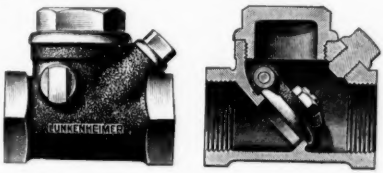
The Jeffrey Coal-Washer at Columbus, Ohio.

THE now completed Jeffrey coal-washer, at Columbus, Ohio, will be of much interest to all coal operators who are at all interested in the washing of their smaller coal with a view of not only getting rid of the impurities, but also of

putting it in a better marketable condition. The Robinson-Ramsay system under which the Jeffrey Company is working has been previously and fully described in our columns. The object of erecting the particular washer under present consideration was to wash such coal as may be sent to the company from time to time with a view of ascertaining the result. Up to the present time quite a number of coal operators have taken advantage of this, the only plant of its kind erected solely for testing purposes. The plant consists of a 200-ton washer and is such as would be supplied to any coal operator. If any coal operators are contemplating the use of such machinery they can arrange with the Jeffrey Company at Columbus to wash one or more carloads, and by examination of the results they can positively determine for themselves whether or not the claims made by the company for the performance of this washer exceed in any wise the actual facts. The Jeffrey Company have had prepared considerable literature relating to this coal-washer, its operation and the results attained with it, consisting of special catalogues and other printed matter which they will supply on request to those seeking further information.

Regrinding Check-Valves.

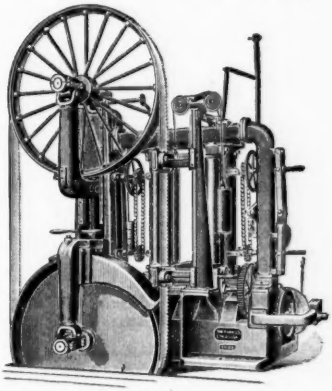
THE engravings accompanying this article illustrate a regrinding check valve manufactured by the Lunkenheimer Company, of Cincinnati, Ohio. The company has, also, branch offices at 108 Havemeyer Building, New York, and 35 Great Dover street, London. Unlike many valves on the market, this valve contains sufficient metal, well distributed, and its design is such that the opening of the disc creates a passage through the body fully equal in capacity to that of the connecting pipes.



Regrinding is performed by first removing the plug, shown in the sectional view, and unscrewing the cap of the valve; a tool then inserted through hole from which the plug has been taken engages the nick in the stud of the removable disk, by which means it can be rotated on the seat and ground to a dead fit with powdered sand and soap in the usual way. The life of the valve is thus prolonged indefinitely. The regular pattern of this check valve is designed for a working pressure of 175 pounds per square inch; but the company also makes a line of extra-heavy valves to withstand pressures as great as 350 pounds per square inch. All its valves are carefully tested and are fully warranted in every respect.

Improved Band-Resaw.

THE machine illustrated herewith is a very strong, substantial band-saw designed for both heavy and light work. It is one of an extensive line of excellent wood-working machines manufactured by the Egan Company, 212 to 232 West Front street, Cincinnati, Ohio. To adapt it to



the wide range of work (it resaws 36 inches wide, 20 inches thick, or to the center of 16 inches), it has a new arrangement of feed rolls, extra heavy shafts, new straining device, and an improved arrangement of guides. The wheels are 60 inch, the blade 6 inch, and the lower wheel is solid. The main features of the design are so well shown in the cut as to render a detailed description unnecessary. The saw will not only perform the work above set forth, but will cut a thin board from the side of a 12 inch timber. The feed-rolls open to take in 8 inches on one side of the saw and 12 inches on the other side. The mandrels are of extra large size and of the best material. There are four heavily-geared feed rolls and two idlers all running in adjustable boxes controlled by two right- and left-hand screws operated by a single hand-wheel. The new straining device controlling the upper wheel and the path of the saw blade on the face of each wheel, is very sensitive and has a side adjustment as well as a forward and backward adjustment. This straining device is arranged with sectional weights and a compound lever so

sensitive that no matter what the vibrations are the strain will take up the slack in the saw blade. This is regarded as adding greatly to the smoothness and perfection of running, which, of course, insures a longer life to the saw blade. Tight and loose pulleys, 36 inches diameter and 8½ inch faces, running at a normal speed of 560 revolutions per minute, are used to drive this machine.

Coaling Warships at Sea.

THE modern warship is utterly unlike that with which even the immediately preceeding generation was familiar. In no department of engineering, with the single exception of electricity, has the march of improvement been so rapid or the innovations so great. One of the latest of these innovations is the "Temperley Transporter" for coaling vessels at sea. From an illustrated description of this device presented in *Scientific American*, April 24, a good idea can be gained of the expedition and convenience with which a warship can be coaled anywhere by this apparatus, from a barge alongside the ship, and without approach to a coaling dock, thus removing one of the previously existing limitations of the modern warship.

The article has for one of its illustrations a picture of the application of this apparatus to the coaling of the U. S. battleship Massachusetts from a barge towed abeam of the ship. The barge containing the coal to be got aboard is brought alongside and attached by lines to the ship at the proper distance from the side of the vessel to be coaled. The apparatus consists partly of an iron beam sixty feet long, attached to the crane at the side of the ship, suitably guyed fore and aft, and inclined so that the outboard end pitches downward toward the barge supplying the coal. This inclination is such that an automatically locking and unlocking carriage running on the beam runs outboard by its own gravity but is pulled inward by a hoisting rope worked by a steam winch, this one rope not only operating the carriage, but also hoisting the load to be conveyed. A suitable stop adjusted at the proper distance causes the carriage to unlock and allow the load to come down to the deck at the point desired. The coal is hoisted and conveyed in bags, an empty bag being supplied to the carriage at each outward run which is filled and returned while the contents of the last one are being stowed. This mode of getting coal on board is both rapid and cleanly. The system permits the supply of coal to ships blockading a port, instead of, as heretofore, compelling vessels of a squadron to proceed successively to coaling stations for the purpose, while the others remain on guard. The Lidgerwood Manufacturing Company, 96 Liberty street, New York, is the sole manufacturer of the Temperley Transporter, which in its various applications has proved an eminently successful invention and has come into extensive use.

Recent Installations.

THE American Engine Co., of Bound Brook, N. J., have just begun the shipment of their new direct-connected generating plants, in which the American-Ball engine is combined with their new line of six pole generators. They are now installing a 75 K.-W. Plant at No. 7 East Seventeenth street, New York, in the building of Deitsch Bros., and a 35 K.-W. plant in the building of the *Evening Wisconsin* of Milwaukee. In addition to this they have orders from the Philadelphia *Enquirer* for a 100 K.-W. plant; the Buffalo *Evening News* a 35 K.-W. plant; the Phelps's Pub. Co., of Springfield, Mass., two 35 K.-W. plants; the New York *Tribune* a 75 K.-W. plant; and the World's Dispensary Medical Assn. of Buffalo, a 25 K.-W. plant.

CATALOGUES AND TRADE PUBLICATIONS.

Continued from page 496.

The Hancock Inspirator Company, Boston, Mass.=(*a*) Illustrated descriptive catalogue of the "Hancock" locomotive inspirators and general jet apparatus. (*b*) Circular letter relating to said catalogue. (*c*) Illustrated pamphlet more specially describing the "Hancock" locomotive inspirator. (*d*) Price list of repair parts (pamphlet form), with directions for connecting and operating "Stationary" pattern inspirators. (*e*) Leaflet containing business announcement.

Pittsburg Pump Company, Pittsburg, Pa., U. S. A.=Illustrated descriptive catalogue and price-list of a line of iron, force, wood, and chain-pumps, and pump material.

American Wire Goods Company, Lowell, Mass. U. S. A.=(*a*) Catalogue of wire coat- and hat hooks, garment hangers, trousers hangers, blind fasts, bright wire goods, wire specialties, and special wire machinery. (*b*) Price list of bright iron-wire goods for cotton and woolen mills, and loom-harness makers. (*c*) Leaflet illustrating and describing the "Yorick" trousers hanger.

The Allen Anti-Rust Mfg. Co. Cincinnati, O., U. S. A.=(*a*) Folding circular setting forth how to prolong the life of an old roof at small expense, by the use of Allen's anti-rust amalgam. (*b*) Price list of Allen's anti-rust japan.